JOURNAL OF THE AERONAUTICAL SCIENCES

AERONAUTICAL REVIEW SECTION

VOLUME 8 MAY, 1941 NUMBER 7

Every village and city in the Western Hemisphere lies within the long range protection of the mighty B-19—newest Douglas Army bomber. The world's largest airplane, it has the world's most powerful engines—four Wright Cyclone 18's of more than 2000 HP each. It foreshadows America's rapidly approaching supremacy in the air.

WRIGHT
Aircraft **ENGINES**

WRIGHT AERONAUTICAL CORPORATION • PATERSON, NEW JERSEY

Division of Curtiss-Wright Corporation

Where we stand in Aviation

IN its relations with aviation, Goodyear occupies the same place it has long held in the automobile and motor truck industries – *that of a major supplier of parts.*

From the earliest days of the motorcar we have been manufacturers of tires, tubes, fan belts, radiator hose, motor mounts and numerous other rubber accessories – and of essential metal parts like rims designed out of our tire experience.

With equal faith in the future of aviation we began, *thirty years ago,* to apply our specialized knowledge of transport problems to the development of better products for all types of aircraft.

In close cooperation with the aviation industry we have perfected improved tires, tubes and other rubber needs – become large manufacturers of related accessories like wheels and brakes – acquired extensive facilities for handling alloy-metals used in aeronautical construction.

Through our subsidiary Goodyear Aircraft Corporation, we are now making available to the aviation industry our long engineering experience in fabricating metal parts for aircraft.

Thus we are creating a mass-production source of supply for wings, nacelles, floats, tails and other control surfaces such as we are now building on subcontract for Glenn L. Martin Company, Consolidated Aircraft Corporation, Curtiss-Wright Corporation and Grumman Aircraft Engineering Corporation.

These facilities round out Goodyear's position as the nation's leading manufacturer of aviation tires, tubes, wheels, brakes and more than 30 other closely related rubber and metal parts.

We believe that our many notable contributions to aviation, including among numerous others the Airwheel and Hydraulic Disc Brake, are the best guarantee of our ability to serve the aircraft industry advantageously in the future as a primary supplier of highest quality parts and accessories.

P. W. Litchfield

Chairman of the Board
The Goodyear Tire & Rubber Company

Airwheel—T.M. The Goodyear Tire & Rubber Company

GOODYEAR

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AIRPLANE TIRES, TUBES, WHEELS AND BRAKES

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That is why every Thompson part that goes into a military aircraft engine is made with the most exacting attention to materials and precision work. For example, certain parts made by Thompson Products are held to dimensional tolerances of five *ten-thousandths* of an inch and are superfinished to a surface accuracy of *one-millionth* of an inch.

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Thompson Products

JOURNAL OF THE AERONAUTICAL SCIENCES

AERONAUTICAL REVIEW SECTION

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Listed below are the leading aeronautical and industrial companies who make possible the publication of the *Journal of the Aeronautical Sciences* through Corporate Membership Dues.

The income from these dues enables the Institute to publish scientific and technical papers in the first section of the Journal without advertising and to devote its pages exclusively to editorial material.

The *Aeronautical Review* is devoted to the dissemination of current aeronautical information of a broader scope and is supported by its advertisers and The Paul Kollsman Library Fund. This library lends aeronautical books and sends them by mail, without charge, to aeronautical specialists in any part of the United States.

The above services provide a source of comprehensive technical information for the benefit of the aeronautical profession and industry.

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AERONAUTICAL REVIEW

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Criticism and Controversy

THERE ARE STILL, so our correspondence tells us, a few of our readers who do not quite understand the editorial policy of the Aeronautical Review. They would have us take sides on some of the white-hot controversies now raging in the industry, or write critical reviews on current aeronautical literature.

This would be a violation of the basic principles upon which the Review was founded. It would minimize its value to the readers. As one of the editorials printed in the April issue stated, the Review has accepted as its task the reporting, as impartially as it can, of the contents of other publications. The literary white feather we wear is no sign of editorial cowardice. It is a white plume we wear, like that of the medieval field judge at a joust, to distinguish us from the combatants. This does not mean we are not in favor of the combat.

We live in strained times at present. Some of our birthrights are being suspended for the period of the emergency. Free access to data such as performance and production figures, the results of certain experiments, the conclusions of particular research, information which formerly was as free as air has been placed under restraint. These inconveniences are deemed necessary for the national good and this restraint is not disputed. Yet history cautions us against disarming science by limiting the individual's right to disagree. Dispute is often the spur to research; criticism, the motive for discovery.

Some one person must be the first to see a flaw in any existing setup, whether it be in design, production method, basic theory or administrative process. If the right to point out this flaw is legislated out of existence for the sake of efficiency, the flaw may become a venerable fallacy and pass for the truth. From this point, civilization either decays or petrifies.

Editorially, we hold fast to our white plume. It takes us out of the combat without removing us from the lists. It charges us with guarding the rights of the combatants. Time itself has proved that in aviation, more perhaps than in any other practical science, the collision of intellects brings forth amazing truths.

Air Law Meets a Milestone

This month the Aviation Industry will celebrate the fifteenth birthday of civil air regulation in the United States. On May 8, 1926, the Air Commerce Act, which gave the Secretary of Commerce guardianship over the behavior of the cantakerous adolescent of the transport business, became law.

Those who were in aviation fifteen years ago will remember that Federal regulation was not hailed with unmixed joy. Owners of unlicensable aircraft, pilots of dubious skill and reputation as well as people with honest principles against Federal interference were loud in their protest. While the early air regulations were lax compared to present statutes, there were those objectors who claimed it would strangle the "infant industry." Nevertheless, the law was written into the books, machinery for enforcing it was set up and Supreme Court decisions were made to prove its validity.

At this point in aviation's history, three motives appeared to push the business of flying from the circus to the air line stage—Air Progress, Air Safety and Air Regulation. Air Progress was the oldest of the three, comprising the desire to fly, aeronautical knowledge and technical development. Air Safety's birthday is a little vague; it happened when some pioneer did something such as "beefing up" a weak part in order to assure himself not only a successful but complete flight or decided that it was too windy to take off. Air Regulation was conceived in order to give the other two direction and purpose.

It is singular that these three, while seemingly separate, have progressed at about the same rate. Some may call this parallel accidental but it is more probable that this growth was dependent upon the stabilizing effect of Air Law on the trend toward constant change sponsored by Air Progress as opposed to the reaction and conservatism of Air Safety.

Air Law has frequently had to take abuse from all sides. Like Air Progress and Air Safety, it has not reached perfection. Being most exposed to the public eye, this agency takes most of the criticism. Nevertheless, in fifteen years of criticism, growing pains and all, Air Law has held up its side of the Aviation Triad.

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of the

Institute of the Aeronautical Sciences

A lending library service of the Institute which makes available, without charge, the latest and more important aeronautical books to members of the Institute and others interested in aeronautical progress.

Membership in the library is open to all members of the Institute of the Aeronautical Sciences and to any person in the United States over 18 years of age who can furnish references which certify as to his responsibility and reliability.

The Aeronautical Reader's Guide

A catalogue of selected aeronautical books available for loan from The Paul Kollsman Library. The Guide lists and comments on books and by indexing them under specialized headings also acts as a valuable reference source for aeronautical specialists, companies, libraries and other organizations.

The Guide is issued quarterly in September, December, March and June, and is priced at $1 for the four issues in each volume. Single copies are not available and subscriptions may only be accepted for complete volumes.

Further information will be sent on request.

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News Review

March 11. Myron B. Gordon, Vice-President and general manager of the Wright Aeronautical Corporation, speaking at the Founders Day Dinner of the University of Cincinnati, predicted that when the world returns to peace-time pursuits, aircraft would carry increasing amounts of air freight.

March 12. Secretary of the Navy Knox opened the new Naval Air Training Station at Corpus Christi, Texas. The new 44 million dollar base, the largest of its kind in the country, has a training capacity of 3,600 cadets a year.

March 12. The first air raid shelter in New York was opened at the Allerton House. The shelter, 45 feet below the surface, is equipped with an auxiliary power plant, sanitary facilities, radio, cots and other equipment.

March 14. Orders for aircraft now on hand call for the building of 75,000 airplanes for U.S. and Great Britain by 1943. Sixty per cent of these will go to the R.A.F.

March 16. Work began on a chain of air bases to connect Edmonton, Alberta, with Alaska. The new fields will have 4,000 foot runways and will be fully equipped with radio and lighting equipment.

March 16. Stearman Aircraft Company turned over to the Army the thousandth trainer built for defense orders.

March 17. Army air corps pilots landed a four-engined Boeing bomber on the frozen surface of a lake in Alaska, hinting the possible use of these bodies of water as Winter emergency airports.

March 18. The Chilean government placed an initial order for 25 Fairchild low-wing trainers—to replace the European equipment used thus far.

March 19. The Mexican Senate promulgated a resolution authorizing President Comancho to permit U.S. military aircraft to fly over Mexican territory.

March 22. The Brewster Aeronautical Corporation announced that contracts had been awarded for the construction of a plant for the assembly and flight-testing of dive-bombers at Johnsville, Pa. The plant will employ 5,000 men.

March 23. The War Department voiced its opposition to the proposal by Senator Clark of Missouri for a unified air force.

March 23. The Commercial Priorities Division of the National Defense Advisory Commission was reported to have relaxed restrictions on new transport types to the extent of permitting Lockheed and Douglas Aircraft to build new four-engined transport types.

April 15. Igor Sikorsky established a Western Hemisphere endurance record for helicopters of one hour and five minutes in the Sikorsky VS-300 at Stratford, Conn.

March 25. Edward P. Warner, on leave from his post as vice-chairman of the Civil Aeronautics Board, left for London to act as aviation aide to W. Averell Harriman, President Roosevelt's personal representative in England.

March 26. C. W. Van Ranst, Ford Motor Car Company experimental engineer, told a meeting of the American Society of Tool Engineers that a 12-cylinder V-type liquid-cooled aircraft engine weighing 1,900 lbs. and producing more than one hp. per lb., was almost ready for mass production.

March 28. The Mormack Lines 17,615 ton merchant ship Mormackmail was reported being converted into an aircraft carrier at the Norfolk Navy Yard. The vessel was completed by the Maritime Commission last Spring and was recently purchased from its owners for $2,956,346.

March 30. The National Advisory Committee for Aeronautics created a sub-committee to study icing problems. D. W. Tomlinson was appointed chairman.

March 30. The Senate Appropriations Committee approved a defense bill appropriation to permit increasing the number of cadets for the Army Air Corps from 7,000 to 30,000 annually.

March 30. The C.A.A. announced that private flying had established an all-time safety record with only one fatality to every 991,842 miles flown.

April 1. Newark Airport, closed to air line traffic since last May, was reopened for service.

April 1. Douglas Aircraft Company announced a blanket increase in hourly wages of between 2½ and 5 cents. Twenty-five thousand employees are affected.

April 2. Air Chief Marshal Sir Robert Brooke-Popham, Chief of British Air Operations in the Far East, and his staff, arrived in Cavite, P. I., for a conference at the U.S. Naval base there.

April 5. The Office of Production Management announced that 1,216 airplanes were built in the U.S. during March for the Army, Navy and commercial use, as well as for export to the Allies.

April 5. The C.A.A. reported 63,113 certified pilots on January 1—twice the number certified up to the same date in 1940.

April 5. Consolidated Aircraft Corporation announced a record crossing of the continent when a four-engined "Liberator" bomber flew from San Diego to New York in nine hours and fifty-seven minutes. The flight was made on February 15.

April 8. Gov. Charles Edison of New Jersey called for the formation of a Civil Air Guard composed of volunteer owners of private airplanes and civilian pilots to serve upon call during any emergency.

April 9. The first of six Boeing Clippers, originally ordered by Pan American Airways and later sold to the British Overseas Airways, arrived in New York on its delivery flight. The new craft covered the indirect

(Continued on page 30)

From the Industry

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Review.

Civil Aeronautics Administration

Commenting upon President Roosevelt's request to Congress today for an appropriation of $2,477,000 to permit the C.A.A. to install ultra high frequency radio ranges and radio landing systems at various points throughout the country, Colonel Donald H. Connolly, Administrator of Civil Aeronautics, said that the ultra high frequency range was the result of development during the past four years by the Radio Technical Committee for Aeronautics, made up of representatives of the Army, Navy, Coast Guard, F.C.C., Bureau of Standards, radio manufacturers, scientific institutions, the C.A.A. and the air carriers.

He said that the first range system operating on these frequencies, which are remarkably static-free and free from any tendency to split into multiples, would be ready for scheduled air line use on May 1st. Special equipment is being installed in the transport planes which will use this route on and after that date.

The New York-Chicago airway is the first link in what the C.A.A. technicians hope will be the eventual conversion of the entire 35,000 miles of Federal airways from intermediate frequencies in the 200–400 kilocycle band to ultra high frequencies between 119,000 and 126,000 kilocycles, Colonel Connolly said.

The new ranges are being established along the New York-Chicago airway at the following points: Easton, Sunbury, Black Moshannon, and Millbrook, Pa.; Cleveland and Toledo, Ohio; Millersburg, Ind.; and Chicago Heights, Ill.

Arrangements for immediate expansion of classes for airport "ground-servicemen" on 14 new airports throughout North Carolina, South Carolina, Georgia, Florida, Mississippi, Alabama and Tennessee were announced. Similar classes have been in operation since the first of the year at airports in Maryland, Virginia, New Jersey and New York, and, at the present time, are coming to a conclusion of the 90-day training period. At the completion of this course trainees are qualified to undertake any and all of the multitudinous duties around large or small airports not requiring the services of a certificated mechanic. Each class is composed of one instructor and ten students. The activity is a special W.P.A. project sponsored by the Advisory Commission for National Defense, and co-sponsored by the C.A.A. and the Office of Education.

"The project was conceived as a precautionary measure to forestall any possible shortage of efficient ground men to meet the increased demand which will be brought about by the expanded aviation programs," said Colonel Connolly, "and our efforts are receiving the enthusiastic support of airport managers everywhere.

"Persons selected for this training are given a thorough indoctrination in the etiquette of airport behavior, the first rule of which is SAFETY, the second CAUTION, and the third THOROUGHNESS."

The trainees are men ranging between the ages of 18 and 35 who have been taken from the W.P.A. rolls and they alternate actual work under the watchful eye of a skilled employee with classroom study directed by an instructor selected by the Office of Education.

Generally speaking, their instructors are men with previous airport experience who have been given a brief, intensive course in teaching technique at some convenient location, under the supervision of an Airport Specialist, and a Specialist in Vocational Training, in advance of the organization of workers classes. The instructors then return to their respective communities and go into action. Trainees are required to learn the federal, state and local field regulations.

They are taught to direct the taxiing and parking of planes at fields where there is no radio direction; to correctly place blocks under airplane wheels; to start engines by hand and by mechanical methods; to handle planes on the ground and to store them in hangars; to clean the ships and their various parts as well as the engines and their accessories.

Aeronautical Chamber of Commerce of America

American aircraft manufacturers are spending three times as much money today as they were a year ago to purchase the materials, supplies and parts needed in the construction of military airplanes for the United States and Great Britain.

A survey released this week by the Aviation News Committee of the Aeronautical Chamber of Commerce of America reports that a group of 20 representative airplane, engine and propeller companies expended $37,903,180 for purchases during January 1941, an increase of 180 per cent over the $13,527,907 spent during January 1940.

These plants except to spend more than $70,000,000 a month by midsummer, almost doubling their January 1941, purchases—or an increase of more than 400 per cent in the 18 months from January 1940 to July 1941.

Approximately three-quarters of a billion dollars will be spent during 1941 by the American aircraft industry for the parts, materials and supplies essential in the production of warplanes ordered by the United States Army and Navy and the British R.A.F., according to informal estimates.

The 20 companies covered in the Aviation News Committee survey include 14 airplane manufacturers, seven on the West Coast—Boeing, Consolidated, Douglas, Lockheed, North American, Northrop and Vultee; and seven in the East—Beech, Bell, Brewster, Fairchild, Glenn Martin, Republic and Vought-Sikorsky Division of United Aircraft.

Also included in the report are four engine manufacturers—Allison division of General Motors, Lycoming, Pratt & Whitney and Ranger, and two propeller plants—Hamilton Standard of United Aircraft and Woodward Governor.

National Aviation Training Association

Action taken by the House Appropriations Committee in Washington, recommending that $25,000,000 be voted for the Civilian Pilot Training Program, constitutes a major success in the campaign of the National Aviation Training Association to win Congressional approval for carrying on the flight-training activity in more than 700 colleges and universities. This proposed fund includes, also, the non-college connected classes.

The Congressional committee reported out a $25,000,000 C.P.T.P. item, increasing the budget bureau's $18,000,000 by $7,000,000. That recommendation, if approved by the Congress, will assure continuance of the C.A.A. flight-training classes on about the same national scale as at present according to calculations by N.A.T.A. officials.

"This action in Congress," said William A. Ong, president of the N.A.T.A., "does not finally assure that flight instruction under government sponsorship will continue after June 30th. Both the House and Senate must yet vote on the appropriations measure. However, we feel greatly encouraged, particularly in view of the fact that our association did not request an appropriation increase, merely asking that the C.P.T.P. be continued as a necessary part of our defense program."

Boeing Airplane Company

The Stearman Division of Boeing Airplane Company, Wichita, Kansas, delivered its 1,000th primary trainer under Army and Navy defense contracts. It was believed to be the first manufacturer to deliver this number of planes under the National Defense program.

The Stearman Division received special commendation for its production from Secretary of the Navy Frank Knox and from Major Gen. Henry H. Arnold, Chief of the Air Corps, recently, when it completed 180 Army and Navy trainers in 16 days. This record was accomplished in a special National Defense effort following an emergency call for additional trainers on short notice by both the Army and Navy.

Elmira Area Soaring Corp.

A summer-time course in gliding and soaring, under direction of John Robinson, 1940 National Soaring Champion, is now offered by the Elmira Area Soaring Corporation, of Elmira, New York. Classes will start May 1st and continue until June 27th, and will be discontinued during the Twelfth Annual National Soaring Contest, held regularly at Harris Hill, Elmira.

Students will have the practical advantages of classroom instruction and all field activities including ground crew training and use and handling of motor, winch and shock cord tows.

Three types of instruction are offered by the school: A novice course of two weeks will provide for the issuance of a private glider pilot's license; the second, the power pilot's course, may be completed in a week and is designed primarily to make a better pilot through knowledge of soaring principles. Upon successful completion of this course a private glider pilot's license may be issued. The third arrangement provides, on a week-end or hourly basis, training for the semi-skilled glider pilot or the power plane pilot who wishes to learn high performance operations. Rates are scaled to cover hourly time in either single or dual place ships, and with or without supervision.

Looking like a gigantic spider web, this wire-mesh disc is used to check aerodynamic unbalance in propellers. The slightest unbalance causes the "web" to flutter.

According to Youston Sekella, President of the Elmira Area Soaring Corporation, special instruction may be arranged for pilots who desire to earn an instructor or commercial pilot's rating. Glider pilots who attend for the purpose of gaining more expert knowledge, and providing their own ship, may receive coaching and launching services under a special hourly rate. Under the program of instruction as planned by the Soaring Corporation, it is expected that the novice pilot will complete his course and be ready to receive his private glider pilot's license within two weeks, weather permitting.

General Motors Company

The new plant of the Aeroproducts Division of General Motors Corporation at Dayton is approaching completion and production of airplane propellers in this plant is scheduled to begin in July according to an announcement made by C. E. Wilson, President of General Motors.

Last June, General Motors acquired the propeller business of Engineering Products, Inc., which had been working on the development of a hydraulic airplane propeller for several years. It was anticipated that in the normal course of events the Corporation would begin the manufacture of propellers after about three years of preparation. Due to the national defense demand, however, development work was intensified and, with the cooperation of the Materiel Division at Wright Field, Dayton, a propeller recently passed Army tests.

All Aeroproducts propellers are of the infinitely variable pitch design in which engine speeds are held constant and variations in load requirements are met by automatic changing of the angle of the blades that are rotating.

Last year, Aeroproducts Division began construction of a propeller testing tunnel and laboratory. The laboratory is now ready for operation. In this laboratory, propellers built in temporary quarters occupied by Aeroproducts Division will be placed on test.

B. F. Goodrich Company

In the first detailed scientific "box score" ever issued on the specific characteristics of synthetic rubber, the B. F. Goodrich Company today disclosed that the man-made product excels natural rubber in four important service properties, equals it in six, and is only slightly below natural standards in three.

The results of a year of intensive testing show that Ameripol, the synthetic rubber which our scientists created from petroleum, soap, natural gas and air, can go to bat for natural rubber 769 out of 1,000 times in the broad field of mechanical rubber goods, V. I. Montenyohl, Vice-President in charge of the company's synthetics division, declared in a statement accompanying an analytical report on the properties of the synthetic compiled in the Akron laboratories.

Very similar in appearance to natural crude rubber, Ameripol can be tubed, calendered, frictioned, spread, milled and vulcanized just like natural rubber, the bulletin said. Special cements have been developed which will permit vulcanization and adhesion to metals, including brass, provided the metals can be suitably roughened by sand- or shot-blasting, it was explained.

Resistance to mineral, animal and vegetable oils and fats, to the oxidizing influence of the metallic soaps used as driers in paints and inks, to heat, and to abrasion particularly in the presence of oil, are among the most valuable funda-

mental properties of the synthetic product.

The bulletin showed that the synthetic substance excels natural rubber in its resistance to aging, oxidation, heat and oil, four mortal enemies of nature's product.

The Glenn L. Martin Company

An educational experiment, designed to supply more aeronautical engineers quickly and also to up-grade others into aircraft specialists, is progressing well at two Maryland universities, it was announced by The Glenn L. Martin Company, co-sponsor with the National Defense Council.

Courses at the University of Maryland are turning mechanical, civil and other classes of engineers into aeronautical technicians and refreshing former engineers who have not pursued their professions for some time. Other courses are giving practicing aeronautical engineers advanced training for increased responsibilities. Still others are preparing men to be tool designers and aircraft inspectors.

At the Johns Hopkins University, qualified engineers are being given intensive instruction in highly specialized subjects, such as electricity as applied to aircraft, plastics, fluid mechanics and cabin supercharging, heating and ventilating. Others are being trained in factory management and time-and-motion studies to create a supply of production technicians.

The courses at Maryland are under direction of Professor S. S. Steinberg, Dean of Engineering, and at the Hopkins under Doctor W. B. Kouwenhoven, Dean of Engineering.

Lear Avia, Inc.

The entire fleet of Douglas airliners on the 6,000-mile route of Pan American-Grace Airways is now being equipped with Learadio ADF-8 automatic direction finders, it was announced today by William P. Lear, President of Lear Avia, Inc., manufacturers of aircraft radio and accessories.

Panagra's unique operating requirements necessitated an unusual installation of this instrument. Each ship is equipped with a complete direction finder, comprised of an automatic station-seeking direction-finding loop, a special five-band receiver remotely controlled from the radioman's station, and two 360° azimuth indicators: one located in front of the pilot, the other in front of the radioman.

In addition, a second five-band receiver unit only, complete with remote control, is also installed at the radioman's station. A special selector switch enables either receiver unit to be used for either direction finding or communications reception.

In normal operations, one unit is constantly in use for directional guidance, while the other remains free for communications work. When it is necessary to obtain precision cross bearings, the two receivers may be tuned to two radio transmitting stations, and almost instantaneous cross bearings obtained by connecting the two receivers alternately to the azimuth indicator, thus eliminating tuning delays.

Each receiver unit is a special superheterodyne covering the frequency range from 195 to 15,360 kcs., in five bands: 195–405, 498–1,195, 1,190–2,832, 2,800–6,720 and 6,400–15,360 kcs. The first three bands of each receiver are arranged for both direction finding and communications reception; the last two bands are arranged for communications reception only.

The loop nacelle base is specially constructed and is completely sealed for sub-stratosphere operation with supercharged fuselages.

Radio Corporation of America

A highly efficient portable radio receiver which receives such important aviation information as C.A.A. weather reports, radio range courses, and airport control tower signals, in addition to standard broadcast programs, has been announced by the Aviation Radio Section of the RCA Manufacturing Company.

Unusually sensitive and selective for a portable receiver, the unit has a 6-tube, 2-band superheterodyne chassis equipped with a built-in static-limiter switch to bring in weak signals above stormy noise levels and to reduce possible engine interference. Its many other features include tuned RF stage, high antenna sensitivity, and 3-gang condenser to provide freedom from adjacent station interference, rubber mounted chassis to withstand shock and vibration, and built-in loop antenna. Unusually good tone is provided by a large permanent magnet dynamic loudspeaker.

When used in a plane, the AVR-102 is ready for operation when connected to the ship antenna. A convenient jack is provided for headphones. The inexpensive, easily installed dry batteries provide for as many as 200 hours of operation.

A simultaneous radio range filter is available which permits clearer reception of weather broadcasts and other voice transmissions without interference from the radio range signals upon which the voice transmissions are superimposed.

Republic Aviation Corporation

Completion of deliveries against a United States Army Air Corps contract for an unspecified number of YP-43 "Lancer" pursuit airplanes was announced by Republic Aviation Corporation through W. Wallace Kellett, President.

The YP-43 is powered with a Pratt and Whitney, 1,200-hp. air-cooled engine, which is supercharged for efficiency at higher altitudes. The plane weighs 6,900 lbs. fully loaded, has a wing span of 36 ft. and is 27 ft., 10 in. long. It carries both 30 and 50 cal. machine guns, and fragmentation bombs.

Speed of the plane has never been released by the War Department but Republic officials announced that the export version, the "Lancer," has been offered, without Air Corps' special equipment, at 375 m.p.h.

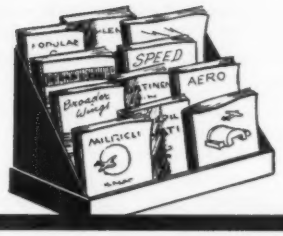
Western Electric Company

A two-unit midget radio receiver for aircraft, that also serves as an interphone, has been announced by the Western Electric Company. It may be tuned continuously or operated as a crystal controlled unit on two "spot" frequencies.

The new instrument, known as the 33-A radio receiver, gives the pilot all the advantages of direct finger tip control—greater operating precision, and simplicity of use—because its radio frequency unit, on which all controls are mounted, fits directly through the instrument panel within arm's length. Since it avoids all flexible shafting, the new receivers require less maintenance than other comparable Western Electric instruments. Its weight has been reduced. Including its separate power conversion apparatus which may be installed in any convenient place, the apparatus weighs but 18 lbs. 7 oz. complete with crystal equipment. Its mounting space in the instrument panel is only $7^{5}/_{8}$ in. by 6 in.

The interphone feature is especially interesting. By lowering the volume of the incoming radio signal, flight personnel may converse freely and simultaneously monitor the incoming messages. When, however, the volume is increased to a satisfactory listening level for the signals, it is still possible by loud talking to override the signals if the necessity arises.

The power unit, which draws only 1.5 amperes, is operated directly from a 24-volt battery supply, although provision for 12 volts may be made optionally. Other interesting performance characteristics of the new receiver include high audio output—700 milliwatts; wide frequency coverage—350 to 625 kc., 3,900 to 7,500 kc., and 6,750 to 12,200 kc.; average sensitivity—5 microvolts for an output of 50 milliwatts The new unit will receive both phone and C. W. telegraph signals. A write-in type dial plate has been provided so that crystal spot frequencies may be conveniently identified.



Periodicals

The reviews in these pages reflect the statements and opinions of the authors of the articles reviewed, and are not to be taken as editorial expressions of the Aeronautical Review.

Aerodynamics

The Elliptic Wing Based on the Potential Theory. Klaus Krienes. A report dealing with the elliptical wing in straight and angular flow on the basis of the potential theory. Conformably to the theory of first approximation upon which the calculation rests, the known requirements regarding the shape of the surface and its angle of attack must be met. A further condition is that the slope of the surface toward the streamlines must be a continuously differentiable function of the points of the surface. If this is not the case, in a given example such as by aileron deflection or wing dihedral, the latter being of importance in sideslips, the discontinuities must be replaced by suitable rounding off. In general, the calculation of a given elliptic surface requires a series of infinitely many potential functions, the coefficients of which are afforded from linear infinite systems of equations. The expansion is stopped with a certain term, depending upon the degree of accuracy desired. Its effect on the integral quantities, lift and lift moment, is practically negligible. An immediate prediction of the induced drag is ruled out, since it would involve all the coefficients of the infinite number of potential functions. Otherwise, the lift distribution at the wing tips does not approach zero or the downwash becomes infinite, which is due to the fact that the load distribution of the lifting line is developed by spherical functions which do not approach zero at the wing tips as do trigonometric functions employed elsewhere. On the wing in sideslip, which can be summarily replaced by a lifting line, the so-called parasite drag

$$W_F = -\int\int (P_u - P_{ob})(w/v)d \times dy$$

would have to be defined first and the suction force on the leading edge subtracted therefrom, where, however, extrapolations are recommended because of the finite number of computed coefficients. Even the resulting pressure distribution is only conditionally valid by few expansion terms, especially near the wing tips. *National Advisory Committee for Aeronautics T.M. 971*, March 1941, 47 pages, 8 illus.

Ueber die Wirbelfreie Stetige Zweidimensionale Bewegung Einer Unendlichen, Reibungslosen Fluessigkeit um Einen Unbeweglichen Zylinder (On the Non-Turbulent Constant Two-Dimensional Flow of an Infinite Frictionless Fluid around a Fixed Cylinder). N. Neronoff. It is assumed that the velocity of a frictionless, incompressible (two-dimensional) fluid is constant at an infinite distance from a solid body, according to the size of this body and the direction of flow; furthermore, that the flow of this fluid is non-turbulent and constant.

In previous reports the problem has been solved by means of a special conformal representation which shows normal sections of the cylindrical surface of the body, which in a general case represent the aggregate of two algebraic curves of any degree.

In the present report the conformal representation used in the above reports is generalized for the case of intermittently projecting points of the profile. *Z.A.M.M.* December 1940, pages 329–335, 3 illus.

Die Waermeubertragung in Turbulenten Reibungsschichten (Heat Transfer in Turbulent Frictional Layers). H. Reichardt. This problem has been investigated many times. Due to its technical importance there are many experimental researches in which empirical or semi-empirical formulas have been set up to meet various conditions and purposes. Researches on the theoretical principles, however, are comparatively rare so that only a few general formulas are available, such as Nusselt's, Prandtl's and the Reynolds theory with modifications by G. I. Taylor.

There is no general theory of turbulent heat transfer from which technically important special cases may be developed. The solution of this problem is closely connected with the investigation of flow phenomena in the immediate proximity of a wall. *Z.A.M.M.*, December 1940, pages 297–328, 13 illus.

Sull'Interferenza di una Galleria Aerodinamica a Contorno Misto (On the Interference of a Wind Tunnel with Varying Sections). E. Pistolesi. This report discusses the calculation of the interference factors of a wind tunnel with varying sections. By means of conformal representation and by the application of De Haller's theory, the interference factors for a profile with varying sections may be

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determined. *Commentationes, Pontifica Academia Scientiarum*, Vol. IV., No. 9, 21 pages.

Accessories

Wind in the Tubes. To solve the problem of the entry of air in the pipelines of hydraulic apparatus in aircraft, particularly hydraulic remote control, an automatic venting valve is suggested as a means of eliminating the air bubbles which create a compressible cushion in the oil pipes and retard operation. *The Aeroplane*, February 21, 1941, page 231, 1 illus.

Airplane Descriptions

Instrument Trainer. Brief description of the Rearwin 8135T, a new version of the Cloudster which is being developed by the Rearwin organization in cooperation with Pan American Airways as a two-place tandem instrument training airplane. Removal of the rear instrument panel permits conversion to a primary trainer. *Air Facts*, April 1941, pages 38, 40, 1 illus.

Fleetwings XBT-12 Basic Trainer. Manufacturer's data on specifications and performance of the Fleetwings basic trainer XBT-12, constructed almost entirely of stainless steel. *Commercial Aviation*, March 15, 1941, page 72.

New Pursuit Interceptor, Model 21-B Climbs Rapidly. Description and details of construction, armament and performance of the Curtiss-Wright 21-B Interceptor. Powered with a Wright Cyclone 1,000 hp. engine, it is said to be capable of climbing a vertical mile per minute and have a maximum speed of 333 m.p.h. at 18,000 ft. *Canadian Aviation*, March 1941, pages 21, 22, 3 illus.

The Sportsman Test Pilot. James B. Taylor, Jr. The Voyager, 1941 model of the Stinson 105, is of the same size and appearance but is now fitted with the Franklin 90-hp. motor equipped with both starter and generator. Controls are lighter than on the 105. Notes on new features and flight handling are presented by the author. *The Sportsman Pilot*, March 15, page 12, 1 illus.

It Makes Its Bow. The Taylorcraft Tandem (Model D) trainer, a high-wing cabin monoplane with 65-hp. engine (Lycoming, Continental or Franklin), is described together with specifications and performance figures. *The Sportsman Pilot*, March 15, 1941, page 26, 2 illus.

Curtiss Navy Dive Bomber. Description of the Curtiss-Wright XSB2C-1 dive bomber powered by the 1,700-hp. Cyclone engine. Although details were not revealed, the bomber is stated to have a top speed of over 100 m.p.h. in excess of present models, with far greater armament and fire power. *Aviation*, April 1941, page 67, 3 illus.

N-3PB Patrol Bomber. Data including performance, armament and constructional details of the Northrop three-place low wing seaplane patrol bomber powered by a 1,200-hp. Cyclone engine. This type was originally ordered by the Norwegian government. *Aviation*, April 1941, page 77, 1 illus.

The Vega 35. Description, construction and performance data on the Vega 35, an all-metal, low-wing Menasco powered primary-secondary trainer. *Aviation*, April 1941, page 75, 2 illus.

The P-38 Interceptor. Information on the performance and characteristics of the twin-engined Lockheed P-38 ordered by the British. This article states that the craft may be built as a two-seater and equipped with additional cannon. *Aviation*, April 1941, pages 72, 73, 7 illus.

Blackburn "Botha" Torpedo Bomber. The newest addition to the British Fleet Air Arm is the Blackburn *Botha* I. This summary of recently released information shows it to be a twin-engined general reconnaissance and torpedo bomber of high-wing cantilever type, powered by Bristol Perseus Mark XA sleeve-valve radial engines. Of all-metal construction, it carries crew of four and incorporates many innovations developed from war experience to date. Structural characteristics are described without specification or performance data. *Aero Digest*, April 1941, pages 155–156, 3 illus.

The Four-Engined Boeing. Notes on the construction and design of the B-17B bomber now being flown to Britain for R.A.F. service. Its high altitude characteristics, semi-monocoque fuselage, wing construction and fuselage assembly are described at length. Additional photographs and captions depict production activity on the Boeing. *Aircraft Production*, March 1941, pages 97–101, 11 illus.

The Caproni Reggiane RE 2000—the Falcho I. Somewhat like the Spitfire, the RE 2000 is used in home defense. It was developed from the designs of the American Republic EP-2 single-seat fighter. Performance is noted; features and specifications are given. *The Aeroplane*, February 21, 1941, page 222, 4 illus.

Inside the Curtiss Pursuit. J. Pearce AuWerter. Description of the Curtiss P-40 pursuit, giving some details of its construction, armament and armor. *Air Youth Horizons*, April 1941, pages 10, 11, 2 illus.

A Dream from the Past. Describing the development of Igor Sikorsky's ideal in aircraft, extensive information is given on the design and performance of the VS-300 helicopter, which embodies the characteristics he has consistently sought for more than 30 years: the ability to rise vertically and hover in the air under perfect control. *The Aeroplane*, February 21, 1941, pages 233–234, 3 illus.

Two R.A.F. Pursuit Ships. Descriptions of the Curtiss P-36A (Mohawk) and P-40 (Tomahawk) now in service with the R.A.F. Details and features of equipment and armament are compared. Speed of the Tomahawk is said to be 360 m.p.h. at 16,000 feet. *Flight*, February 27, 1941, pages a–c, 10 illus.

New Fleet Air Arm Types. Descriptions, three-view drawings and photographs of the Grumman G36A, known as the Marlet by the R.A.F., and the Fairey Fulmar two-place fighter. Both of these airplanes have been used in aircraft carrier operation by the Fleet Air Arm. *Aircraft Engineering*, February 1941, pages 37–39, 6 illus.

The Curtiss Tomahawk. Blueprint pages of three-view drawings of the Curtiss P-40 with many of its specifications given. *Aeronautics*, March 1941, pages 44, 45, 3 illus.

Features of the Tomahawk. Designated the "Tomahawk" by the R.A.F., the Curtiss P40 liquid-cooled Allison-engined monoplane being shipped to Britain can be assembled with all modifications in about 300 man-hours. Notes on construction and specifications are given. *Aircraft Production*, March 1941, pages 109–110, 8 illus.

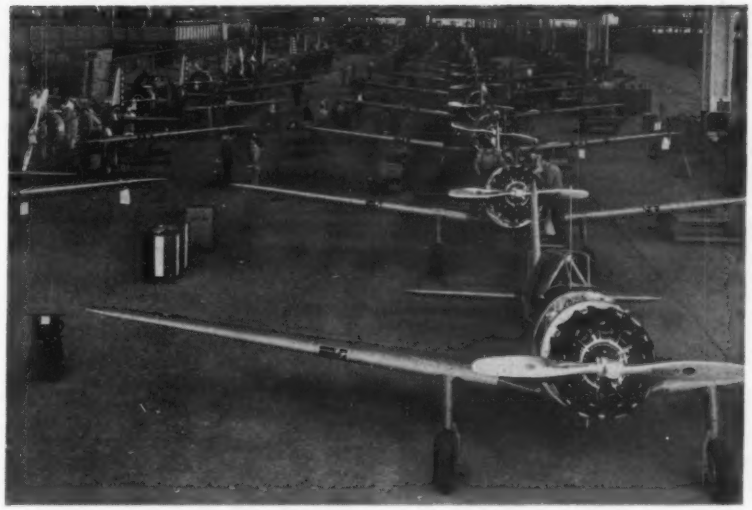
Tricycle Attack Bomber. A description and constructional critique of the Douglas "Boston II" attack bomber, an export version of the high-wing DB-7 powered by twin-row Pratt & Whitney Wasps. This type was originally ordered by the French, but the R.A.F. took over the order when the French government capitulated. *Flight*, March 6, 1941, pages f, g, h, 10 illus.

The Breda 65 Attack-Bomber. Designed for attack operations in conjunction with ground forces, this

fighter is the most heavily armed of Italian single-seat fighters and is somewhat similar to the Fairey Battle. Specifications and performance figures are listed. *The Aeroplane*, February 28, 1941, page 254, 4 illus. and three-view.

The Caproni Ca 33 Colonial Bomber. Description and performance figures on the Caproni 133 high wing tri-motored monoplane, powered by three 460-hp. Paggio Stella radial engines. This type, developed from the Ca 101 and 111 which took part in the Ethiopian war, is used as a bomber and troop transport. It is armed with two gun emplacements, one under and one on top of the fuselage. *The Aeroplane*, March 7, 1941, 5 illus.

Monocoupe. A conversational report on the characteristics and performance of the latest model Monocoupe, with much detail on its handling in flight. *Air Facts*, April 1941, pages 16–25, 2 illus.



Vultee BT-15 trainers near the end of the assembly line at Downey, Calif.

Air Policy

Going to Seed. Russ Brinkley. The case history of a rerated C.P.T.P. instructor, just inside draft age, who because of lack of requisite educational qualifications cannot be accepted as an Army pilot. It is stated that if this man is drafted, he and hundreds like him may be put into cavalry or infantry, and their knowledge and skill will be wasted as far as National Defense is concerned. The Civilian Air Reserve, a group of pilots who could not meet the rigid Army qualifications, would, according to this writer, be able to take over secondary jobs in aviation while the acceptable Army pilots could be spared to fly the fighting craft. Direct regulation and subsidy of such a group is suggested to provide both discipline and financial backing. *National Aeronautics*. April 1941, page 21.

The Story of Federal Aircraft. Report of a debate in Parliament regarding the failure of the government-owned company, set up last July, to get into production on Avro-Ansons. *Canadian Aviation*, March 1941, pages 28, 29, 60, 2 illus.

Note from Washington. H. C. Braund. Description of the organization of the Office of Production Management and its personnel together with a general discussion of British orders for war material and British optimism regarding American ability to change over from peacetime to wartime mass production. *Canadian Aviation*, March 1941, pages 30, 31, 1 illus.

Don't Ground Private Flying. William W. Brinkerhoff. Reasons why private flying should not be curtailed for the duration. Also given are specific contributions to the Army and Navy Air Training program which have been made by the Civilian Pilot Training Program in supplying hundreds of re-rated instructors and thousands of Flying Cadets are discussed. *Air Trails*, April 1941, pages 18, 19, 56, 57, 5 illus.

Definition of Function. J. M. Spaight. Description of the functions and organization of the Air Council, Air Staff and Air Ministry. In outlining the reasons why the Air Council and a Secretary of State for Air were created it is shown that the British realized the importance of aviation as a separate and independent department, and also the necessity for a combination liaison and buffer organization to stand between it and the inevitable political pressure. The outline of organization makes it evident that aviation has become one of the largest and best organized departments in the British government. *Aeronautics*, March 1941, pages 74, 77, 78.

Air Strengths. Digest of "The Truth about Our Defense Program," by T. P. Wright which appeared in the January issue of *Aviation*, and was reviewed in *The Aeronautical Review* for February (pages 3 and 11). Mr. Wright offers an engineer's estimate of relative air strength and production rates, and by plotting the latter approximates the time when the combined production of England and the United States will surpass that of the Axis powers. He also offers the engineer's methodical reasoning which has led him to conclude that America's most practical defense policy entails ever-increasing aid to the democracies. Aircraft production problems in the United States are also analyzed. *Flight*, February 27, 1941, pages 175, 176, 3 illus.

"Give Us the Tools, America!" Bruce Foster. Examining the quality of American aircraft, this writer finds them to be good structurally and aerodynamically and good fighting aircraft when fitted with armament to meet British requirements. Early victory is held to depend on the acquisition of rapidly increasing numbers of military aircraft from America in addition to those made in England. 1940 exports to England increased considerably over 1939 in size as well as number, but fell short of advance estimates. Elimination of organizing problems in the machine tool and allied industries is expected to improve production expansion and export rate materially. *Flight*, February 20, 1941, pages 158–160, 1 illus.

Air Strategy—XLII. Greece and Albania. Captain Norman Macmillan. The Italian problem of an invasion of Greece is explained in terms of the German tactics against Norway. It is said that the Italians ran into difficulties by exactly reversing the German strategy. Because of the British Mediterranean fleet the logical sea attack against Crete and Athens had to be forgone, and operations launched from the mountainous "Narvik" end of that country. It is said that the Italians were obviously trying to obtain by threat what they

were afraid to gain by action, and Greece simply called the bluff. Possible future developments are discussed and attention called to the need for a mobile Bomber Command for quick action on any front. *Flight*, February 27, 1941, pages 177–179, 1 illus.

A Letter to Americans. Charles A. Lindbergh. Sounding his views in support of an isolation policy on the part of the United States in the current war, the writer likens the position of the United States to that of both France and England on the opening of this war—contending that unpreparedness due to "refusal to make the sacrifice essential for adequate rearmament . . . brought the curse of war on Europe . . . defeat to France and devastation to England." Drawing on his personal observations on visit among major European powers during months preceding the war, he elaborates on facts and factors which he considers contributory to the critical condition of unpreparedness in which he feels this country stands today.

Commenting on "British propaganda" relative to the need for materials, not men, and to the effect that "a British victory is essential to American security," reasoning is offered to prove these views erroneous. Summing up, an analysis is given of the "cons" of the air invasion of America hypothesis, in the effort to show that it is impracticable and illogical at the present time, in spite of the fact that "the effectiveness of military aviation is still underestimated. The writer assigns this hypothesis partially to propaganda, partially to hysteria and partially to a "misconception of the so-called 'air invasions' of Norway and Holland by the German airforce." *Collier's* March 29, 1941, pages 14, 15, and 75–77, 2 illus.

Wings for the Legion Edwin W. Luther. The writer, a member of the American Legion National Convention Resolutions Committee, indicates the close relation between the growth of aviation in the United States and the progress of the American Legion. Support that the Legion has given the industry as well as aviation in National Defense has been felt by those interested in flying. To continue their work and interest in aviation, the National organization of the Legion has created an Aeronautics Commission. This group formulated an aviation program to be fostered by state and local organizations throughout the nation. Their activities include the promotion of a sound military and naval aviation policy, consistent promotion of civil aeronautics, increasing air markings, airport building and improvement, aviation scholarships and allied activities. These programs are similar in many ways to the local N.A.A. programs, and cooperation and joint action between local Legion and N.A.A. units is encouraged. *National Aeronautics*, April 1941, page 17, 1 illus.

Airports

"—Ill Housed." William D. Strohmeier. In quest of more adequate hangar facilities for the private flyer, the writer makes his apologies to defense building and proceeds to decry the lack of shelter for some 3,000 private airplanes and the improper arrangement of housing facilities already available at most airports. Blaming the situation on antiquated management of airports, it is suggested that hangars of the interlocking Tee type, which will house five or six airplanes and cost less than $500 per unit, would solve the problem. Such hangars pay for themselves in less than three years on an average monthly rental of $15 per ship. *Air Facts*, April 1941, pages 12–15.

Putting an Airport to Work. Reed G. Landis. Air terminal capacity from the viewpoint of the municipality, the airport operator and the air line management. The aeronautic capacity of any airport is broken down into civic, economic and functional uses. To serve the community it must, according to the writer, contribute to the community's scale of living. The public also derives some recreational benefit from watching the new medium of transportation perform. The economic capacity of the airport is determined by simple bookkeeping. Amortization of the capital investment, maintenance and operational costs also influence this capacity. The functional capacity of the airport is determined simply by the number of take-off and landing operations the airport can handle under varying conditions with the layout and equipment provided. Two hundred air line schedules per day is set as the maximum any airport can handle under modern conditions. Close study of these facts and figures indicate that new airports are needed in most communities to handle both scheduled and non-scheduled air traffic. *National Aeronautics*, April 1941, pages 9, 55, 1 illus.

Willful Waste and Woeful Want. C. G. Grey. The suggestion is made that the Land Branch of the Air Ministry permit the cutting of grass from sod airports in England for use as cattle fodder. The article criticizes the Air Ministry's stand that cutting and stacking this grass would interfere with airport operations. *The Aeroplane*, March 7, 1941, page 288, 1 illus.

Air Transport

Ocean Air Cargo. Grover Loening. This article is a reply to the statement made by Col. Charles A. Lindbergh before Congress that it was impossible now or in the predictable future for aircraft alone to carry large quantities of material across the Atlantic. As grounds for the writer's opposition a comparison is made between the airplane which carried Col. Lindbergh across the Atlantic in 1927 and the Douglas B-19. He points out that the progress made in boundary layer control, jet propulsion and assisted take-off have made an 8,000-hp. airplane with a carrying capacity of fifty tons and a cruising speed of 300 m.p.h. quite possible in the not-too-distant future. A comparison between this future freight carrying aircraft and the average surface vessel shows that on the basis of year-round operation, this future craft could be profitably operated on transoceanic cargo operation. *National Aeronautics*, April 1941, pages 7, 8, 2 illus.

Flying Is Safe. The public, this article states, gets its impression of the air lines chiefly through the newspapers. For that reason, five recent air line accidents have placed emphasis on aviation hazards rather than the underlying safety record of air travel. Definite reassurance is drawn from the year by year decline in the accident rate and from the fact that engine and structural failure have virtually vanished. The causes of recent accidents are laid chiefly to pilot error, insufficient margins of operational safety, the need for a workable absolute altimeter and other causes. Remedies for these failures are recommended. *National Aeronautics*, April 1941, pages 10, 11.

Wilderness Castaways. James Montagnes. An account of several instances where airplanes have been forced down in the Canadian wilds. In the old days pilots sometimes traveled for days overland on foot to the nearest settlement. Now they are told to stay with their airplanes and light signal fires as rescue planes are sent out after them as soon as weather permits. *Air Trails*, April 1941, pages 22, 50, 4 illus.

Aircraft Electricity as the Airline Operator Sees It. P. C. Sandretto. It is shown that the growth of electrical demands on airplanes is due mainly to the problems encountered in operating the airplanes and hence electrical systems are the chief con-

cern of operators. Existing electrical systems are discussed from the operator's standpoint under the headings of "trouble," "weight," and "facilities."

A new system is described for the airplane of the future, which is assumed to have a gross weight of about 100,000 lbs., and a power demand of 30 kw. By means of variable-frequency systems a considerable weight saving is forecast. *SAE Journal*, April 1941, pages 154–159, 4 illus.

Coordinating Airways Traffic on Electrical Record Board. S. P. Saint. In view of the great increase in number of daily airways clearances which seriously complicates the coordination of traffic control at La Guardia Field, a design is suggested for a new type of electrically controlled traffic record board which is said to be simple, fool-proof and easy to put into operation. As proposed, the author claims that the chief advantages over the type of board now in use would be the elimination of the human equation, with substantially increased safety, and that the capacity of the proposed board could be increased indefinitely.

Its design and operation, with the facilities made possible, are described in outline. *Aero Digest*, April 1941, pages 47–48 and 50, 3 illus.

Air Mail and the War. Dr. Max Kronstein. A survey of the effect of the military conflicts taking place in various parts of the world on air mail service. In Australia many of the routes have been curtailed due to the shortage of personnel, while proposed lines have had their opening dates postponed. Across the Pacific, on the New Zealand-Australia route, Pan American alone provides air mail service. The study also covers the extension of Japanese air lines across China, supplanting foreign service wherever possible. Air links to Japan's Pacific possessions have also been established. The horse-shoeing of air mail routes by the British in order to avoid conflict areas, the shuttling over the Mediterranean, changes in services over Central Europe and the North and South Atlantic are also given. *Airpost Journal*, March 1941, pages 208–211, 220, 221, 2 illus.

Regulations for Charter Operators. Tom Park. Commenting favorably on proposed Federal regulation of chartered air transport operations. Following a summary of the report to the National Safety Council by Jerome Lederer, chief of the Civil Air Board's Safety Bureau, there are set forth certain specific procedures which are said to have been followed by a very successful charter service operated with an excellent safety record. *Southern Flight*, March 1941, pages 8 and 34.

Eagle *vs.* Swastika. Raymond Arthur Davies. A commentary on air transport competition in South America and the virtually "give-away" services which the writer says are being conducted by German and Italian controlled air lines in the effort to dominate air lanes on the continent to the exclusion of Pan American Airways. *Commercial Aviation*, March 15, 1941, pages 50, 51 and 70, 4 illus.

Armament

Intermediate Caliber Aircraft Cannon. Louis Bruchiss. The present war in Europe indicates, according to this writer, that heavier caliber armament is necessary for modern aerial combat. Even though the modern rifle caliber may have a rate of fire up to 1,500 rounds per minute, if that speed is divided by the average burst time of a machine gun, minus the percentage of tracers which have no fire power, each gun can score only sixteen direct hits per second under ideal conditions. The modern all-metal airplane can stand this fire quite easily. Although multiple installation of these guns, mounted to have their fire converge at between 300 and 500 yards, has increased their power, the divergence at greater distances is too great for effective scoring.

It is claimed that more effective fire can be achieved by the use of light ordinance, such as the Madsen 20 and 23 mm. guns which have been known to penetrate inch thick armor plate at 600 yards. Typical installations of this type armament, and a comparison of their advantages over 30 and 50 caliber machine guns, are discussed. Effective types of installation, inboard in twin-engined craft or in the wings in single-engined craft are described. *Aviation*, April 1941, pages 36, 37, 136, 138, 7 illus.

Avigation

Astronomical Avigation. (No. 4 of a Series.) Frederick Harrison Tregenza. A previous article indicated that it is possible to obtain a line of position by observing a single object; but it is possible to obtain an accurate "fix" only by obtaining cross bearings upon two recognized objects.

It is stated that it is possible to obtain the accurate position, or an absolute fix, only from astronomical cross bearings obtained from simultaneous observations upon two heavenly bodies. This method cannot be used in daytime by aircraft, except in rare instances when the sun and moon are visible at the same time; but it can be very conveniently and successfully used at night by making simultaneous observations on two stars. The method is explained and demonstrated by helpful diagrams. *Commercial Aviation*, March 15, 1941, pages 45–46 and 52, 5 illus.

Biography

Wings around the World. Donald W. Douglas' aviation career, which began when as a cadet at Annapolis he saw the Wright brothers demonstrate their flying machine to the Army at Fort Myer. Douglas's first paying job in aviation was a $500 per year assistantship at the Massachusetts Institute of Technology. In a quarter of a century, aircraft bearing his name have been taken to almost every outpost of civilization on air lines serving 57 countries. *National Aeronautics*, April 1941, page 13, 1 illus.

Business and Finance

The War and Air Finance. A. S. Wade. General analysis of Great Britain's business and financial position in her war economy. It is stated that costs of this war have run far beyond those of the last for comparable periods, and that Germany's finance system is not apt to break down until she suffers serious military reverses. The prevention of inflationary spirals is discussed together with the incalculable value of the American lease-lend policy in helping to prevent such inflation. *Aeronautics*, March 1941, page 37.

Design

Some of the Limitations on Increasing Airplane Speed. Frank W. Caldwell. Highlighting potential means for increasing present-day airplane speed, the value and practicability of various methods are weighed. The writer finds further streamlining a major factor, but discounts reduction of fuselage frontal area as impractical at the present time.

Viewing the propeller as a critical element in speed increments, methods are suggested for overcoming progressive loss in propeller efficiency due to progressively excessive blade angles at speeds above 300 m.p.h. The utilization of the engine exhaust to furnish a jet for supplementary propulsion has proved a feasible source of speed increases. The compressibility shock wave is an effective barrier to more speed, but aerodynamic knowledge is said to be sufficient to design away from this condition for some time.

High altitude flying offers an attractive means of increasing speed performance because the variation in air density increases the effective speed range of the wing surfaces, effecting speed increase without increase in power. The present limit on augmented speed at high altitude is set by the problems of cooling the engines and compressing and cooling the carburetor charge. *Aero Digest*, April 1941, pages 100–101.

Designing for Machinability. (Part 2.) James E. Thompson. The characteristics of turning and boring machine operations and the more common design errors which affect the economy of parts so machined are given. Turning and boring design practice is analyzed to establish design principles which will achieve the most effective application of these machine processes. *Aero Digest*, April 1941, pages 114, 117 and 118, 9 illus.

Socket Head Cap Screw Design Applications. W. C. Stauble. Among devices adopted in developing high speed production in the aircraft industry is the socket head cap screw, which it is said can be applied to confined spaces and permits the design of a more compact structure with a corresponding saving of weight and a more efficient streamlined contour. Feature of this type screw is an internal driving principle in which a key is used to effect its tightening. Applications to aircraft design and its comparative advantages are explained in this article. *Aero Digest*, April 1941, pages 136 and 139, 8 illus.

Why a Rear Engine Installation. Part II. Robert J. Wood. The second installment on the problems met and overcome during the development of the Bell P-39. Three major questions had to be answered: how to build a suitable structure which would afford lightness, strength and accessibility, how to develop a suitable extension drive to deliver power from the engine in the center of the fuselage to the propeller, and finally, what would be done about vibration resonances occurring in the aircraft structure generated by the propeller or the drive shaft.

Although extension shafts had been used in experimental military craft abroad, Bell engineers got most of their experience with the Airacuda types which were equipped with a sixty inch shaft. The development of the 120 inch drive shaft required for the new design was achieved through close cooperation between the engineering staff of Bell Aircraft and the Allison Co. The article contains a technical discussion of the manner in which appropriate shafting and gear mechanisms were developed and a description of the unique structure of P-39. Some of the growing pains of the new type and how they were remedied are also described. *Aviation*, April 1941, pages 46, 47, 142, 144, 4 illus.

Gust Load Factor Principles. Francis R. Shanley. A simplified presentation of basic gust load factor theories, written to supply pilots and other non-engineering personnel with this information. The article first expresses simplified versions of load factor formulas, then supplies information on the effect of increased air speed on gust loads. *Aircraft Engineering*, February 1941, pages 42, 43, 2 illus.

This Wing May Win the War. T. Benson Hay. This article dramatizes the development of the wing section designed by David R. Davis which has been used on several types of aircraft produced by the Consolidated Aircraft Corp. In an article proposed for publication to a lay public, the struggle of a poor inventor who triumphs over the opposition of the skeptical engineer is a theme which can be much embellished. No brochure published by the inventor himself could have been more flattering or contain wider claims of superiority.

The article will be widely discussed and probably cause certain resentment because it gives the impression that engineers have closed minds which can only be pried open by a radical improvement which they cannot understand. When the engineer reads that any one wing section "has revolutionized the theory of flight" and that the curves "cannot be plotted with standard engineering methods, he will be curious to examine these claims further. *Saturday Evening Post*, April 12, 1941, pages 36, 39, 107–108, 110 and 112, 3 illus.

Air-Cooled *vs.* Liquid-cooled Aircraft. John G. Lee. Data are presented on the drag, weight, cooling and fuel consumption of air-cooled and liquid-cooled power-plant installations. Based upon these data the design of three groups of air-cooled and liquid-cooled airplanes is postulated. When these groups are compared upon a basis of equal size and weight, the air-cooled aircraft are found by the author to be superior in the pursuit, bomber and transport types. *Journal of the Aeronautical Sciences*, April 1941, pages 219–229, 17 illus. Also *Flight*, March 13, 1941, pages h–210.

Thread-Cutting Screws for Fastening. J. B. O'Connor. The results of a series of tests conducted on the use of thread-cutting screws in light alloys, to provide more information on this type of fastening revealed some interesting data. Sample joints were subjected to shear, axial tension, vibration and corrosion tests, comparing the results with standard flush rivets subjected to the same conditions. The results, indicated in the article, showed that the thread-cutting screw had many characteristics which would favor it in aircraft use. *Aviation*, April 1941, pages 64, 158, 4 illus.

Prone Pilots. The case for combat airplanes, especially fighters in which pilots lie prone. Experimental work is said to be going on in this field. Advantages are given as greater speed through lessing frontal area, greater maneuverability due to the fact that the human body in the prone position can withstand greater acceleration or gravity loads for longer periods, as well as added safety through simplifying the problem of armor protection. *Air Trails*, April 1941, pages 10, 11, 55, 56, 2 illus.

Engines

Experimental Investigations on Freely Exposed Ducted Radiators. W. Linke. The present report deals with the relations between the open areas, the drag, and the air flow as observed on freely exposed, ducted radiators—the air conductivity being modified from zero to one unit. The most advantageous forms of ducts are derived therefrom.

In conjunction with theoretical results, the individual components of the drag of ducted radiators are discussed and general rules established for low-loss ducts. The influence of the wall thickness of the ducts, of the length ratio of the exit, and the effects of sonic velocity on diffusers are dealt with by special measurements. *N.A.C.A. T.M. 970*, March 1941, 30 pages, 25 illus.

Use of Charts for Flow Discharge Calculations. O. Lutz. Various problems in connection with engine design involve flow-discharge calculations which are rendered difficult both on account of the large number of external variables that enter into the computation—i.e., changes in discharge area during the process, change in volume of the cylinder, pressure, etc., and changes in the thermal constants themselves of the flow medium. A fairly accurate solution that does not involve an excessive amount of labor can be ob-

tained only through the extensive use of I-S tables. In the present report, a solution is offered in the form of a different method making use of the *I-S* tables of Lutz and Wolf. *N.A.C.A. T.M.* 972, March 1941, 6 pages, 8 illus.

Modern Aircraft Valves. A. T. Colwell. Tracing the development of American and European engine valves, present types are described as to designs, materials, manufacturing processes, operation and maintenance. A constant clearance valve mechanism to meet all American requirements is pointed out as a needed major development. Data is presented on research into the improvement of gas flow in the valve ports. *Commercial Aviation*, March 1941, pages 30–4, 12 illus.

Dieselmotorn och Luftkriget (Diesel Engines and Aerial Warfare). While American, French and English designers experimented with the Diesel, the Germans had a practical Diesel in the Junkers Jumo 205 long before the outbreak of the war, it is said. They equipped mine-laying flying boats with the 700 hp. Jumo E. Two new types are reported under construction: the Jumo 206 of 1,050 hp., having six cylinders with opposed pistons, and a 2,000-hp. double V engine. Approximate diameter of the latter is 1 m., the frontal area 0.74 sq.m., length 1.85 m., and the V-angle at 90°. This engine is suitable for long distance scouting planes, but is still in the experimental stage. *Flygning*, February 1941, page VII.

Comparison of Automatic Control Systems. W. Oppelt. This report deals with a reciprocal comparison of an automatic pressure control, an automatic r.p.m. control, an automatic temperature control, and an automatic directional control. It shows the difference between the "faultproof" regulator and the actual regulator which is subject to faults, and develops this difference as far as possible in a parallel manner with regard to the control systems under consideration. Such an analysis affords, particularly in its extension to the faults of the actual regulator, a deep insight into the mechanism of the regulator process; for this purpose, certain important, practical cases require only cursory treatment, while others of less importance must be explained.

The results of the comparison of these four arrangements, even at the same steps in the consideration, are quite different from one another, since the systems to be regulated manifest differences. Differentiation between direct and indirect control is shown to be unnecessary for this analysis. *N.A.C.A. T.M.* 966, February 1941, 71 pages, 10 illus.

The first step in the production of a Wright Cyclone engine is the sand mold for casting the cylinder head. A finished sand mold is shown in the casing at the workman's right. The core is shown in the foreground. Specially mixed sand is held in place by hundreds of headless nails to permit deep finning.

Cirrus Engines, Major and Minor. Paul H. Wilkinson. Descriptions of the 150-hp. Cirrus Major and 90-hp. Cirrus Minor in-line, air-cooled aircraft engines built in England by the Cirrus Engine Department of Blackburn Aircraft Ltd. *Aviation*, April 1941, pages 71, 156, 3 illus.

Dynamic Engine Suspension. H. V. Shebat. A decade ago, the criterion in engine mounts was complete rigidity, a practice which transmitted power plant vibration directly to the entire structure of the airplane. This practice has gradually given way to provisions for elasticity in engine mounts. The accepted method for the dynamic suspension of power plants, a lineal descendant of the whiffle-tree used for harnessing horses, is explained and its history is outlined. *Aviation*, April 1941, pages 62, 63, 152, 7 illus.

Altitude Performance of High-Output Aircraft Engines. R. N. DuBois. This paper deals principally with a description of the methods used in, and a discussion of the results of, an investigation of possible altitude performance with liquid-cooled engines of high output and consequent high ground boost.

As the first step in the investigation of altitude performance the power of the engine cylinder under all possible conditions of manifold pressure, manifold temperature, and exhaust pressure is determined. The single-cylinder engine laboratory employed can produce any desired exhaust suction; manifold pressures up to 150 in. Hg; inlet air temperature up to 400°F.; and handle engine speeds up to 5,000 r.p.m.

Maintenance of power at altitude by means of the exhaust-driven turbo compressor, the article states, affords a most convenient way out for the engine manufacturer; the troubles, if any, are transferred to the builder of the turbo and of the airplane. He considers "worthy of considerable attention" the use of a two-stage supercharger with an auxiliary engine to drive the first stage. He explains that this arrangement is especially applicable to large airplanes.

Other supercharger arrangements discussed are the single-staged geared compressor; two-speed drives; continuously variable drives; two-stage geared superchargers; and modified two-stage installations, such as two-speed both stages, by-passed first stage, and the two-speed first stage.

The two-speed first-stage method of using two stages is the most satisfactory yet considered, the writer believes, since three steps of supercharging reduce the amount of throttling required and therefore improve the overall efficiency of the system. *SAE Journal*, April 1941, pages 138–147, 15 illus.

Possibilities of the Two-stroke Cycle for Small Aircraft Engines. A. R. Rogowski. In order to reduce the first cost and maintenance of the small airplane, and thus make private flying more universally available, there is need for a simple, reliable, low-cost engine with performance

equal to the present small four-stroke unsupercharged power plant. The piston-ported loop-scavenged two-stroke engine is considered for this purpose, using as a basis the results of tests on an experimental cylinder of this type. It is concluded that this engine would be most satisfactory, provided the fuel consumption at high outputs could be reduced by means of relatively inexpensive fuel-injection equipment. *Journal of the Aeronautical Sciences*, April 1941, pages 230–235, 9 illus.

The Case for the Carburetor. Recent talk about the superiority in economy and high altitude performance of the direct fuel injection system used by certain types of German aircraft engines prompted the Royal Aircraft Establishment to run a series of comparative tests between the Junkers Jumo 211, inverted Vee type, twelve-cylinder, liquid-cooled aircraft engine and the most similar type used in England, the Rolls-Royce Merlin X. The Junkers engine used direct injection, while the Merlin used a conventional carburetor. Despite the rumor about low octane fuel used by the Luftwaffe, analysis of the fuel found in the tanks of the Heinkel 111 bomber from which the German power plants were taken revealed that 92 octane gasoline was used exclusively. An account of the manner in which the comparative tests were conducted is given. Among the conclusions reached were that the complicated fuel injection system showed neither marked saving in fuel or superior performance at high altitude and that the injection system comprises 1,576 parts against the carburetor's 433. This entailed a production problem as well as one in maintenance. *Flight*, March 6, 1941, pages b, c, d, e, 10 illus. *The Aeroplane*, (**Performance at Height**), March 7, 1941, pages 289–292, 10 illus.

Heat Flow in Engines. Edward A. Smith. Discussion of heat flow through cylinder walls and fundamental factors involved in computing it. Periodic variation of temperature, B.t.u. output of the fuel, conductivity of the cylinder wall, the non-uniformity of cylinder wall conductivity due to different strata of oil, oxidized metal surface, zone of cyclical variation and normal zone of cylinder wall, and static and active coolant zones are explained. *Flight*, February 27, 1941, pages 180, 181, 4 illus.

The Shape of Piston Ring Grooves. E. Mickel. A study of the importance of the radius of curvature at the base of the grooves of piston-rings in resisting high stress. For the same durability, the article indicates, it is possible to reduce the space required on the piston ring groove to half the size by means of the unloaded groove radius instead of the rounded groove base. A simple method for producing such piston ring grooves is suggested. *Aircraft Engineering*, February 1941, pages 35–37, 10 illus.

High Power Aircraft Engines. A. W. Judge. A survey of high-powered aircraft engines as used in present types of combat airplanes, together with a discussion of new designs and development work now under way. Progress in engine design and performance over the past ten years is shown in addition to photographs of better-known British and American models. Patterns of cylinder arrangement are shown and explained and the writer offers his conclusions regarding respective merits of liquid-cooled and air-cooled aircraft engines. *Aeronautics*, March 1941, pages 48–54, 15 illus.

Germany's American Legacy. Description of newest German engines derived directly from American air-cooled radial motors. Manufacturers of these are identified, and comparative specifications are tabulated. *The Aeroplane*, February 28, 1941, pages 252–253, 6 illus.

Gliding and Soaring

Motorless A.T.C. Alexis Dawydoff. Outline of C.A.A. requirements for a glider Approved Type Certificate. It is said that many amateur-built gliders have crashed due to faulty design and construction. The writer explains and discusses present engineering requirements. *Air Trails*, April 1941, pages 24, 58, 59, 3 illus.

High Altitude Flying

High Altitude Test Piloting. Description of the high altitude tests of the Lockheed P-38. The process of supercharging pilots by 30 minutes of moderate exercise breathing pure oxygen is outlined together with a discussion of medical research on the effects of high altitude flights carried on at the Mayo Clinic during the past two years. *Canadian Aviation*, March 1941, pages 23, 59, 4 illus.

History

Western Air Express Celebrates 15th Anniversary. A brief outline of the Western Air Express which began service between Los Angeles and Salt Lake City on April 17, 1926. The line's service, which originally carried passengers and mail together in a single-engined Douglas biplane, now uses equipment such as Douglas DC-3's and Boeing 247's. *Aviation*, April 1941, page 51, 3 illus. Also *Aero Digest*, April 1941, pages 52, 54 and 96, 5 illus.

Australian Aircraft Timbers. The story of an attempt, 20 years ago, to establish in Australia an aircraft factory using only Australian timber as the basic construction material. The research, accomplished before the venture finally failed, is said to have proved beyond doubt that Australia could produce all the right kinds of timber in sufficient quantity to suport a substantial aircraft industry. *The Aeroplane*, February 21, 1941, page 230, 1 illus.

A Real Fairey Story. A review of the history of this famous British aircraft firm through twenty-six years. It goes back to the "heroic" days of aviation when C. R. Fairey, who later founded the company in 1915, was yet experimenting with models. Highlights are given on Mr. Fairey's associates of early war days and now, all of them distinguished pioneers in British aviation. Fairey innovations from the first flap gear down through the III series to the large flying boats are reviewed in succession. There follow descriptions of more recent advances—overseas reconnaissance, all-metal design, the Fox, Firefly and T.S.R. models, dive bombers and pressure cabins. The work of the completely modern and up-to-date research department in aerodynamics particularly is given much space. *Flight*, February 20, 1941, pages 151. 152a-l, 153, 154, 44 illus.

Instruction

How to Behave in a Turn. Wolfgang Langewiesche. As a discourse on the technique of undertaking a turn in flight, this detailed but simple description of theory applied to the maneuver displays an appreciation both of misconceptions on the part of the unseasoned pilot and of hazards to be met in the accomplishment of turns. Essence of his counsel is: "Never turn an airplane by rudder; always turn it by laying it over on its side and lifting the nose around with your stick." *Air Facts*, April 1941, pages 47–58.

Sheet Metal Student. George R. Neumann. Description of a three-months' course in sheet metal work given by the Luscombe School of Aeronautics by a former student. *Air Trails*, April 1941, pages 21, 44, 3 illus.

Flight in a Harvard. Ronald A. J. Keith. The editor of Canadian Aviation compares flying in what he calls

the "hay-meadow days" with a practice aerobatic flight in a Harvard advanced trainer. Loop, roll, tail spins, and practice dive bombing are described, together with a few moments "under the hood" flying on instruments. *Canadian Aviation*, March 1941, pages 24–26, 59, 6 illus.

Girl Meets Plane. A picture account of the flight education of a typical New York girl white collar worker, following her progress from the physical examination by the C.A.A. doctor to solo flight. *Friday*, April 4, 1941, pages 20, 21, 10 illus.

Dodoes Are My Job. William P. Sloan. A civilian instructor describes the job of putting Flying Cadets through primary flight instruction. Private flying schools have taken over most of the primary or first stage training of the Army Air Corps Cadets. The writer, a flight instructor from the Ryan School of Aeronautics, outlines various stages of flight training and tells of the average student pilot's reactions during these important first hours of instruction. *Air Trails*, April 1941, pages 15, 53–55, 1 illus.

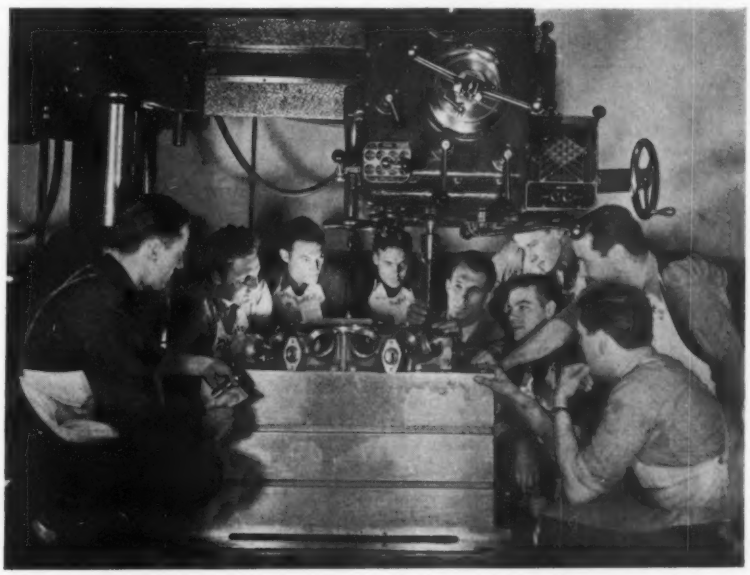
Randolph Field—1941. Captain Edward W. Suarez. Current organization and conditions of U.S. Army flight instruction at Randolph Field are described and compared with those of a year ago, with the conclusion that the necessity for speeding up pilot and instructor training has been successfully met without impairing instruction standards. *The Sportsman Pilot*, March 15, 1941, pages 10, 30 and 32, 2 illus.

Flight Test Your Own Airplane, Part II. Brian Sparks. Instructive discussion of performance tests for measuring maximum rate-of-climb, best climb air speed and absolute ceiling of your airplane. *The Sportsman Pilot*, March 15, 1941, pages 14, 36 and 37.

Training Types. M. de Bunsen. A British woman flyer discusses current American and British primary trainers and outlines characteristics of what in her opinion would be the ideal training airplane. *Aeronautics*, March 1941, pages 38–40, 8 illus.

Acrobatics Are Easy. Daniel J. Brimm, Jr. The first in a series on aerobatics, written as a supplement to the C.P.T. Manual, Bulletin No. 23. First, certain precautions for the student aerobat, such as checking the date his parachute was last repacked, checking the safety belt, removing or tying down loose objects such as cushions, belts, checking engine performance on the ground, etc., are given. Simple maneuvers, the Chandelle, the Lazy Eight, Wingover, Power Stall and Falling Leaf are described in this installment. In all of these maneuvers, the writer not only tells how they are performed, but the physical reaction to each is described and precautions for safety during them are outlined. *Aviation*, April 1941, 32, 33, 132, 134, 140, 3 illus.

Trained or Trimmed? and **You'd Better Be Trained!** Milton F. Baldwin. Parts I and II of an article intended to reveal fraudulent aviation training schools and help the prospective student to select a sound school. Sales methods of unreliable training organizations are described and criteria are suggested for the student's use in determining a responsible school Part II includes a tentative list of schools approved by the publishers of the magazine who plan to continue this series in future issues. *Southern Flight*, March 1941, pages 12, 13 and 28; April 1941, pages 13–14.



A group of trainees study the technique of radial drill operation on the crankshaft of a 14-cylinder Wright Cyclone engine as part of a comprehensive program to provide personnel for the Wright Aeronautical Corporation's new plant now being completed at Cincinnati, Ohio.

Instruments

Compass Deflection Due to Unbalanced Electromagnetic Fields. Norman J. Clark. Analyzing compass needle deflection effected by electromagnetic fields surrounding conduits in which the electric currents are not balanced, several methods are explained for eliminating or correcting this type of deflection, which is pronounced the most troublesome of compass deflections. The positive solution is said to be the utilization of alternating current for operating pitot-static heaters, instrument ring lights and compass deflectors. *Aero Digest*, April 1941, pages 111 and 113, 5 illus.

Aircraft Instrument Repair and Service. Brief excerpts concerning aircraft instrument repair and maintenance from a handbook of Kollsman airplane instruments recently published by the company. Included are notes on dissembly, broken pivots, broken jewels, parts out of balance, worn out gear teeth, and method of cleaning. *Canadian Aviation*, March 1941, pages 33–37, 3 illus.

Flight Level Indicator. Robert W. Knight. This paper is a report of an experimental instrument designed for the purpose of providing means to effect positive vertical separation between aircraft in flight. From reports of certain air carriers, personnel of the services, and the industry generally, the consensus appears to be in favor of a single, simple, positive method to control cruising altitude levels. To accomplish this, one plan is the employment of non-adjustable, uniform instruments with a common base.

This method of flight altitude control is intended for cruising and holding altitudes only, and suggests a solution to this phase of the air traffic problem. *Journal of the Aeronautical Sciences*, April 1941, pages 242–245, 1 illus.

Maintenance

Warbird Doctors. James L. H. Peck. The writer's account of a visit to an Army Air Corps maintenance depot, describing the routine servicing of the fighting aircraft and the process by which the airplanes are rebuilt periodically for continued service in National Defense. Army servicing, according to this article, is more thorough than even air line repair routine. The process by which Air Corps mechanics are selected and trained is also related. *Scientific American*, April 1941, pages 212, 213, 214, 4 illus.

San Antonio Air Depot. A survey, chiefly in pictures, of the largest of the U.S. Army Air Corps' four overhaul bases at Duncan Field, San Antonio, Texas. This base, responsible for the major overhaul of over a thousand airplanes, has upward of 1,900 trained mechanics, many of whom are civilian employees. Besides the equipment for overhaul of every type of craft—from the Flying Fortress to the Link Trainer—this depot is geared to make major changes such as the replacement of complete turrets, blisters, and conversion of export type fighters into advanced trainers. The personnel of this station includes one hundred N.Y.A. students who are serving a four-year apprenticeship. *Aviation*, April 1941, pages 38–41, 22 illus.

Manufacture

Bombers from Mid-America. A series of articles describing four large bomber assembly plants in the Central West. The first two pertain, respectively, to the plant of Consolidated Aircraft at Fort Worth, and that of Douglas Aircraft at Tulsa. The types of bombers to be constructed, the plants themselves and the methods used in gearing these plants to the defense program as a whole are the subjects discussed in the series. *Southern Flight*, March 1941, pages 10–11, 7 illus.; April 1941, pages 16–17, 4 illus.

Photo Loft System. J. K. Highley. Lockheed's chief loft engineer details this new method for speeding up the making of aircraft templates and cutting down the gap between engineering drawings and the start of parts manufacture. *Commercial Aviation*, March 15, 1941, pages 56 and 58, 8 illus. Also **Photographic Lofting,** *Aircraft Production*, March 1941, pages 85–86, 2 illus.

Hurricanes Headed East. Recounting the obstacles encountered by the aircraft division of Canadian Car and Foundry Company in building Hurricane fighters to British specifications, this staff article shows how they have been met through educational orders and the development of Canadian and American sources for tools and parts formerly unique to British production. The rapid growth and present condition of the plant are described. *Commercial Aviation*, March 1941, pages 25–29, 15 illus.

Refrigerated Metal. One of the factors that has retarded aircraft production was the fact that duralumin sheet stock had to be pressed into shape within two hours of the time it was solution treated in order to prevent splitting due to age-hardening. A method for extending this period, thus increasing press efficiency, has been reported by the Institute of Metals. J. C. Arrowsmith and K. J. B. Wolfe of Pressed Steel Co., Ltd., experimented with a system of storing heat-treated blanks at subnormal temperatures, as has been done for some time with dural rivets to inhibit this premature age-hardening. Temperatures and methods applied to large sheet surfaces are given. *Scientific American*, April 1941, page 237.

New Wasps' Nest. Construction on the new plant of the Ford Motor Car Co., which will produce Pratt & Whitney aircraft engines, was started at Dearborn in the dead of winter. Thanks to a radical departure in building procedure, the plant will be ready to turn out engines in less than six months after ground was broken. A huge tent-like structure was built, using 900,000 sq. ft. of fibre board, and the interior was heated with charcoal braziers. When completed, the building will house the aircraft apprentices school, the lightweight alloy foundry, and will start on the production of 4,236 Pratt & Whitney engines and power plants of original Ford design as soon as the plant is completed. *National Aeronautics*, April 1941, page 12, 2 illus.

Cost in Air-Craft Manufacture. A. T. E. Wanek. A cost officer for the British Air Purchasing Commission gives his own suggestion for the way in which estimated costs in aircraft production should be arranged and prepared by the manufacturers. The writer offers a breakdown under various sub-headings for the actual cost of fabrication, and in addition offers suggestions for figuring allowance for preparation, operational lay-out costs, tool costs and detail costs. *Canadian Aviation*, March 1941, pages 47–50, 3 illus.

Drop Hammer Technique. J. S. J. Hlobil and J. A. Petrie. A collection of important facts, figures and general operational rules for the use of drop hammers in the mass production of aircraft. The article outlines the progressive forming of sheet alloy on the drop hammer which controls wrinkles in the metal. A table of set-up and tear-down time on various die weights is provided. The methods of finishing the die stamped parts is outlined. General rules and engineering consideration developed from actual practice, such as the composition, dimension and thickness of the metal specified for drop hammer work, working tolerances, radii, dimensioning and deepforming of the parts, angles and restrictions on design are discussed in detail. *Aviation*, April 1941, pages 54, 55, 160, 162, 13 illus.

Conveyor Belt System. The new engine assembly plant at the Pratt and Whitney factory has accelerated production to over a million hp. per month. This has been achieved through the use of a conveyor belt system geared to feed the assembly line with finished parts. At the new plant, 400 engines at various stages of assembly completion must be supplied with finished parts. This is accomplished by an overhead conveyor belt, fitted with suspended pans into which the finished parts are placed. Through careful stock control, the parts arrive at the particular station in time to be installed. *Aviation*, April 1941, pages 44, 45, 124, 7 illus.

Superfinish—Its Aircraft Applications. M. W. Petrie. Higher ratios of horsepower per pound has created a demand for bearings with fine metallic surfaces. Describing the attributes of various surface finishes for bearings, the metallurgical changes in the structure at the outer surface of the bearing which cause improper clearance, flaking and other conditions resulting in failure of the bearing surface, are analyzed.

It is explained that with the aid of superfinishing operations, where no heat is created because of extremely low pressures, slow abrasive speeds and multimotions, the layer of tool marks and metal that is metallurgically different from the body of the metal is removed, exposing the true crystals of the bulk metal to serve in an undisturbed condition as the bearing surface. *Aero Digest*, April 1941, pages 125–126 and 129–130, 10 illus.

Production of Martin B-26 Medium Bombers. Harry F. Kniesche. This article sketches the precise and simple tooling system developed by The Glenn L. Martin Company to permit speedy, economic, quantity production of the B-26 with a low skill factor on the part of workmen.

Among the tooling methods used to

eliminate the need for skilled personnel are both new methods of part formation and new assembly fixtures intended to reduce the number of possible errors and simplify working procedure. Many parts normally welded together and composed of several pieces have been designed as punchings made with steel drawing dies. Frames are assembled on vertical revolving fixtures with photo-layouts and all the manufacturing information is on the base of the jig as a constant guide to the workman. Holes for attaching frames and stringers are coordinated to permit assembly in the manner of an erector set. The 63 pieces of metal skin for each fuselage are preformed to a double curvature on a stretch press, to insure perfect and easy fit. Other phases of production are similarly simplified. *Aero Digest*, April 1941, pages 133–134 and 193, 7 illus.

Plant Layout. C. W. S. Parsons. Another in a series on efficient utilization of plant space. This article points out that airplane production is expanding so rapidly that excellent opportunities are provided for the scientific layout of entirely new plants. The writer contends that what must actually happen is that the job must be laid out and a building built around it, but the plant must be so planned that it can be changed to suit altering circumstances.

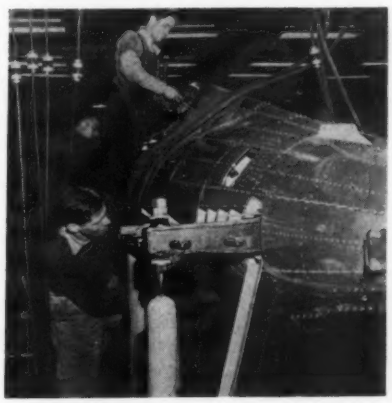
The methods of studying the particular physical problems of plant arrangement with the idea of speeding production are studied. *Aviation*, April 1941, pages 48, 49, 148, 150, 2 illus.

Standardization in Aircraft Manufacture. A review of papers and discussions by American engineers and production specialists at a recent S.A.E. National Aircraft Production meeting, theme of which was that modern total war is won not so much on the firing line as on the production line. Attention is centered on the urgency of standardization and methods for achieving it. *Aircraft Production*, March 1941, pages 105–8, 6 illus.

Time Study. Notes on the advantages of bulk and line production and the relation of time study to their development. Attention is given to preliminary study of the production line and the problems of synchronizing its operations. *Aircraft Production*, March 1941, page 86.

Transparent Coverings. For high-speed aircraft, transparent plastic materials permit streamlining to reduce eddies and drag and afford a superior type of cover wherever transparent apertures are required in the airframe structure. Such materials are easily cut and machined with ordinary woodworking tools, as explained in this article. The operation of machining, the design of the frames and installation of units are set forth. *Aircraft Production*, March 1941, pages 77–78, 8 illus.

Cone-Pointed Screws. Suggestions for the design of simple, inexpensive jigs and fixtures by the use of screws with conical points. *Aircraft Production*, March 1941, page 84, 4 illus.



Fuselage shop workers stretch the skin over the frame of a Republic "Lancer" P-43.

Pressings in Aeroplane Construction. E. J. Ritter. A comprehensive study of the use of draw-presses, drop hammers and hydraulic presses in forming light alloy parts for aircraft. Alloys available for this type of usage, and the making and handling the various types of dies are discussed. This article, which appeared in 1938, is translated from the German publication *Luftwissen*. *Aircraft Engineering*, February 1941, pages 45–47, 54, 20 illus.

Mass Production of Military Aircraft. H. J. A. Wilson. Summary of the problems of mass production applied to the manufacture of military aircraft. Mentioned are extent of tooling, time lag on tooling, problems of assembly and sub-assembly, availability of production equipment, accurate calculation of man-hours using available equipment, design and accurate forecast of output for tools and jigs. *Aeronautics*, March 1941, page 81, 82, 1 illus.

Producing the "Shadow Blenheim." Part III. Bruce Foster. Concluding this series on the manufacture of Bristol Blenheims, assembly processes are described. The first two stages are operational and the last entails inspection only, from which the aircraft goes to the "dope shop" for application of external finish and then to the flight shed for final adjustments and testing. *Aircraft Production*, March 1941, pages 79–84, 13 illus.

Where Airplanes Come from. W. B. Courtney. In a chatty summary of an interview with Lawrence D. Bell, president of Bell Aircraft Corporation, illumination is thrown on those factors which necessitate exhaustive preparations, checks and tests as essential to the turn-out of dependable, efficient military aircraft. The complexities of the product are shown to necessitate more complicated production methods than in other industries in spite of the aids which have been developed to simplify production problems and permit wider application of mass production principles to the manufacture of airplanes.

The full-throttle significance of the unprecedented expansion brought upon the aviation industry overnight is clarified together with the inordinately serious problems incident to meeting expansion requirements. Incidentally, the article throws considerable light on the personality of the man who is "father and mother to the Airacobra." *Collier's*, April 5, 1941, pages 14, 15 and 68–72, 11 illus.

Materials

Symposium on Spectrographic Analysis. Thomas A. Wright, Chairman. Introduction to the papers and discussion which follow in this issue, representing the substance of proceedings of the Symposium at the 1940 annual meeting of the A.S.T.M. The papers cover the whole range of spectrographic analysis and emphasize the practical features and uses which have brought spectrography into being; an attempt is made to correlate the requirements of metallurgical engineers dealing in non-ferrous metals with the ability of the spectrographer to meet them. *A.S.T.M. Bulletin*, March 1941, page 27–54.

Flammability of Plastic Sheets and Films. W. A. Zinzow. Describing some of the work leading up to the A.S.T.M. Tentative Method of Test for Flammability of Plastics, which is reprinted at the end of the article. *Modern Plastics*, April 1941, pages 59, 60 and 62, 3 illus.

A Simple Flexure-Testing Machine for Plastics. G. H. Brother, W. C. Suttle and L. L. McKinney. A discussion of the design and calibration, the applications, and the results obtained from a simple flexure-test apparatus built in accordance with specifications of the A.S.T.M. as a substitute for the heavy, more expen-

sive machines previously available for testing plastics. *A.S.T.M. Bulletin*, March 1941, pages 13–16, 5 illus.

Using Plywood Methods in Aircraft Production. D. Perry. Discussion of modern fabrication methods using molded plastic bonded plywood, as condensed from the writer's paper published in the March issue of the *Journal of the Aeronautical Sciences*. Historical background, and development of plastic bonding and fabrication methods are outlined together with a description of super-pressed high density plywood. The use of plywood for ribs, wing and tail surface covering, and laminated spars as well as fuselage construction, is also described. *Canadian Aviation*, March 1941, pages 41, 44, 50, 6 illus. See also: *Modern Plastics*, April 1941, pages 53–58, 82, 84 and 86, bibliography and 9 illus.; *Commercial Aviation*, March 15, 1941, pages 41–44 and 52, 8 illus.; *Journal of the Aeronautical Sciences*, March 1941, pages 204–216, bibliography and 14 illus.; *Aeronautical Review*, April 1941, page 20.

Engine Cooling. Myron A. Coler of the Paragon Paint and Varnish Co.'s engineering department stated that his experiments proved that, contrary to popular belief, paint or enamel on an air-cooled cylinder does not act as an insulator but actually promotes better cooling. Some colors improve the cooling rate as much as 13 per cent. Setup and figures on the experiment are given. *Scientific American*, April 1941, page 207.

Wright Field's New 20-Ft. Wind Tunnel. The new 20-ft. wind tunnel now being completed at Wright Field, to supplement the two present tunnels, one of 5 ft. and the other of 14 in. jet diameter, will enable the Field's investigators to simulate actual flying conditions more closely than ever before. Its structural features and facilities are described here. *Aero Digest*, April 1941, page 140, 1 illus.

Choice of Material for Aircraft Construction. F. T. Hill. A discussion of available aircraft material and some of the compromises which must be made in aircraft design and construction due to raw material supplies. Included are steel alloys, aluminum alloys, woods, plastics and plastic bonded plywoods. *Aeronautics*, March 1941, pages 34–36.

Medicine

High Altitude Experiments. Notation on the work of Wright Field Aero Medical Research Laboratory in providing officers for instructors at their home stations for pilots, flying cadets, and other flying personnel in the various techniques of high altitude flights. *The Military Surgeon*, April 1941, pages 432–433.

Meteorology

A Report on the Difference between the Precipitation Records as Taken on the Standard Canadian and United States Rain-Gauges. F. Napier Denison. This article describes a comparison of rainfall observations as taken at the Victoria College on the Canadian standard raingage of 3.57 in. diameter, and the standard U.S. 8 in. gage, and a similar comparison made at Seattle Weather Bureau. The results appear to show that the small gage records more rainfall than the larger gage, but the difference is less during windy weather. No cause for this difference is given at the present time. It is also pointed out that the cedar stick causes a displacement of .01 in. per in. in the 8 in. gage. *Bulletin of the American Meteorological Society*, February 1941, pages 65–67, 2 illus.

The Mount Washington Icing Research Program. David L. Arenberg and Patrick J. Harney. Abstract of a paper presented at the Institute of the Aeronautical Sciences Ninth Annual Meeting. The paper reports on investigations of (1) measurement of liquid water content, (2) measurement of drop size distribution, (3) structure and physical properties of rime and ice, (4) testing and possible development of de-icing equipment and (5) meteorological conditions necessary for severe icing. Methods and calculations used in the study are outlined. *Bulletin of the American Meteorological Society*, February 1941, pages 61–63.

A Study of Pre-Warm Frontal Fog at Portland, Oregon. Archer B. Carpenter. The Portland Airport is located within the City of Portland, and subject to the usual city smoke. Prevailing winds are from the northwest and southwest due to its location on the Willamette River. Ocean air may reach Portland from the northwest, through the lower Columbia River gorge, and from the southwest through a gap in the Coast Range. It is also exposed to the interior climate of eastern Washington and Oregon, through the upper Columbia River gorge. At times the interplay of continental and ocean air may become delicately balanced for hours, with the continuation of prewarm frontal fog. It has been found that formation and duration of prewarm frontal fog may be forecast within reasonable limits. When the precipitation at Portland is warmer than the surface air into which it is falling, formation of pre-warm frontal fog is favored. Gradient winds of 20–30 m.p.h. are most favorable for light pre-warm frontal precipitation. Duration of the fog depends on a continued supply of cold surface air, warm precipitation falling into the cold surface air, and light surface winds. *Bulletin of the American Meteorological Society*, February 1941, pages 47–51.

Further Comparisons of Meteorological Soundings by Radio Waves with Radiosonde Data. Albert W. Friend. Presentation of comparative data between radiosonde and radio wave soundings made at Boston between June 24 and 29, 1940. It is stated that radio wave pulse echoes can be utilized for continuous recording of all meteorological discontinuities to the base of the stratosphere. Experiments, theory and recent development in this field are outlined. *Bulletin of the American Meteorological Society*, February 1941, pages 53–59, 6 illus.

Recent Fog Investigations. Sverre Petterssen. *Journal of the Royal Aeronautical Society*, March 1941, pages 71–88, 9 illus. See also: *Journal of the Aeronautical Sciences*, January 1941, pages 91–103 and 114, 9 illus.; *Aeronautical Review*, February 1941, page 20.

Nagra Instrument for Undersokning av de Hogre Luftlagren (Instruments for the Exploration of the Upper Atmosphere). Alf Nyberg. A description of several types of meteorographs, their applications, and how to make proper deductions from their recordings. *Flygning*, February 1941, pages I–III and VIII, 8 illus.

Flygplan Som Orsak Till Bildning Eller Upplosning av Moln (Formation and Dissipation of Clouds Caused by Airplanes). H. Henrikson. The writer considers in detail meteorological conditions at which the above phenomena take place; he calculates the amount of steam in the exhaust gas of the engine, and the variation of relative humidity of the air due to it within the area around the course of the airplane. Some examples of artificial dissipation of clouds are given, and of ice formation in cloud-free air. A bibliography on these subjects concludes the article. *Flygning*, March 1941, pages I–V, 6 illus.

On the Technique of Forecasting Low Ceilings and Fog. J. J. George. As far as the formation of fog is concerned, air loses its maritime properties after being exposed to sunshine over land for only a few hours. Accordingly, fog which forms over land

may be called "radiation" when the trajectory of the air has been mostly continental, and "advection" when it has not been over land during the day preceding the formation of the fog. It is found that radiation fog forms only when the air has been under a cloud cover a part of the previous day, and a forecasting method for such formations is developed. The forecasting of advection fog is shown to be more complex, and various methods necessary in such work are discussed. Examples of each type are presented.

An analysis of the causes of errors being made at present in the forecasting of fog and low ceilings is made, and indicates that substantial improvement in short range forecasts of such conditions is possible at this time. Suggestions for the elimination of present faults are made and a systematic method of forecasting described. *Journal of the Aeronautical Sciences*, April 1941, pages 236–241, 7 illus.

Adjustment of Airport Station-Pressure Records to Former City Station Elevation. W. W. Reed. Few mercurial barometer installations at airport stations of the Weather Bureau have been made to coincide with the station elevation at the city office. Beginning with July 1939, pressure records at the airports were made official for synoptic purposes and published in the *Monthly Weather Review*, causing breaks in the homogeneity of pressure records. Tables are presented giving corrected airport pressure readings in order to extend the former homogeneous series over the interruption to September 1940, when the airport readings became official. *Monthly Weather Review*, December 1940, pages 344–347.

Military Aviation

British Commonwealth Air Training Plan. Cy Caldwell. A complimentary report on the program and progress of the empire's united effort to provide the best possible training to the largest possible number of pilots, as viewed by the writer on a recent inspection visit to three Royal Canadian Air Force training centers in Ontario.

Comprising Canada, the United Kingdom, Australia and New Zealand, the joint undertaking has its center in Canada under the direct administration of the Canadian Government. At a cost of $1,000,000,000, it calls for 116 training centers with 100 aerodromes, 1,860 buildings and an administrative staff of 40,000 men. As for operation, the program is already ahead of schedule.

Firing training is enhanced by the "Bombing Teacher" and a power-operated turret, both simulating actual conditions in the air, according to the writer in his description of training procedure. He finds aerodromes and facilities comparable to those in larger American cities and far superior to those of the last war. Most notable difference between the two wars, he believes, is the far greater earnestness in the attitude of the student pilots and air observers toward their work. *Aero Digest*, April 1941, pages 44–46 and 96, 7 illus.

New Tactics for New Aircraft. "Flight Lieutenant." New fighters equipped with cannon have necessitated new techniques of approach and attack, according to the writer. It is said that fast fighters armed only with machine guns get into and out of firing range so quickly due to great speed and short gun range, that despite increased fire-power they have time for only a short burst before the pull-up. The greater effective range of cannon equipped fighters, while it complicates the problem of getting into correct position for an attack, enables the pilot to maintain fire over a longer period of time. The new tactics based upon this fact are described. *Aeronautics*, March 1941, pages 55, 56, 3 illus.

By Any Other Name. Photographs and simplified data tables of the American-built airplanes being used in the R.A.F. Tables contain the dimensions, power, loading, range, armament and performance of twenty-three types of bombers, patrol craft, trainers and pursuit airplanes. *Flight*, March 13, 1941, pages b–g, 23 illus.

Nippon's Air Power. Discussion of the Japanese army and naval air forces. It is estimated that the Army has about 64 squadrons roughly divided into one-third fighter and fighter reconnaissance, and two-thirds bomber and bomber reconnaissance squadrons. The Navy is credited with between 40 and 50 squadrons, and is third only to Great Britain and the United States in aircraft carrier tonnage. Naval aircraft are divided between fighters, dive-bombers, torpedo-bombers and reconnaissance aircraft. Various types of Japanese military aircraft are shown and described. *Flight*, February 27, 1941, pages e–174, 12 illus.

Shadow of the Night Bomber. Captain Norman Macmillan. The writer analyzes the effect that the fewer hours of darkness will have on British and German night-bombing operations during the coming spring and summer. The problem faced by the German High Command of timing an invasion attempt to take advantage of the hours of darkness is shown to be highly complex. The writer believes that chances for success would be greatest during the period shortly before the vernal equinox. The effect of varying periods of darkness on the design of night bombers is also discussed. *Aeronautics*, March 1941, pages 58–61, 3 illus.

Japan's Air Strength. An estimate of Japan's air power must be derived from miscellaneous fragments of information, due to the rigid censorship which has long surrounded both civil and military flying. The study available shows that the Japanese air strength has no central command, and is divided into Army and Navy air forces, much like the United States. Almost all of the aircraft types used are imitations of European or American types, or admitted foreign designs built under license. The industrial capacity of Japanese aircraft plants, as well as aircraft materials sources, are definitely limited. The article makes the observation that the Japanese air forces could not cope with a major war even with the Eastern Air Force of the Soviet Army. *The Aeroplane*, March 7, 1941, pages 280–284, 18 illus.

Inside the "Egg" Crate. Pictures and descriptive captions of the living and working quarters aboard a U.S. Army B-18A bomber. *Air Trails*, April 1941, page 20, 7 illus.

We Bomb by Night. John R. Hoyt. An account of what a night bombing mission would be as carried out in one of the B-17 "Flying Fortresses" which have been sent to England. Difficulties of navigation and locating the target are described, as well as the tense moments of the sighting "run" and an encounter with defending night fighters. The writer also mentions the non-sealing gas tanks and shortage in defensive fire-power which give the crew some anxious moments. *Air Trails*, April 1941, pages 12, 13, 60–62, 5 illus.

History of the Pursuit. Double spread showing famous types of pursuit airplanes from the Bristol Bullet to the Lockheed P-38. *Air Trails*, April 1941, pages 16, 17, 24 illus.

Ordeal by Interview. Michael Gray. A personalized account of the writer's own experience in meeting the final interview required for acceptance as an R.A.F. pilot. He describes the Selection Board as completely fair

and cautions applicants against panic. *The Aeroplane*, February 28, 1941, pages 260–261, 4 illus.

Bomber Pilot. Quentin Reynolds. R.A.F. bomber pilot Eric Walsh spent his leave with the writer in London recently and the result is this story which depicts the training and experiences such as have made thousands of seasoned R.A.F. pilots out of "raw timber" almost overnight. *Collier's*, March 29, 1941, pages 11, 71 and 74, 1 illus.

Miscellaneous

Flight Refuelling. Sir Alan J. Cobham. Reviewing developments of the past ten years in refuelling aircraft in flight, trials and experiments are described. Theoretical considerations of the effect of large increments in wing and power loadings on the performance of aircraft are discussed. Of future application, it is said that using aircraft with a range of 5,000 miles, all the main routes of the world could be handled by some fifteen refuelling stations. For military purposes, it is held that the use of large airdromes, being static, would be impractical for both operative and tactical reasons.

Concluding that flight refuelling is the best form of assisted take-off, as it makes possible the practical use of definite high-wing loading, the writer contends that a most urgent development should be the design of a long-range high-wing loaded aircraft (wing loading 80 to 90 lbs. per sq.ft.) that would depend on flight refuelling for its practical operation. *The Royal Air Force Quarterly*, March 1941, pages 155–164.

Hangar Flying (Basement Hangar). Dr. Boy N. Collier. With flying a large part of his work and family activity, the writer turned to a "hangar-house" in the full sense—built his home around his seaplane hangar, described in this article. *The Sportsman Pilot*, March 15, 1941, page 13, 1 illus.

All China Was Our Factory. Charles Healy Day, as told to William Winter. The story of Charles Day's six years of building war planes for China and playing hop-scotch with Japanese air raiders sent to put an end to his work, details the humors along with the hazards of his "build-'em on the run" experiences. Engineering and drafting personnel were an easy catch compared to the combing of all China for qualified mechanical labor which it seems just wasn't to be had. How the problem was solved, only to be followed by rout as the result of a flood, again by air raids and finally by invasion makes a travelogue in the telling, not to speak of the peregrinations of the machinery, equipment and fabrication materials and the problems incident to their repeated removals. *Saturday Evening Post*, March 22, 1941, pages 20–21, 41, 43–44 and 47, 9 illus.

Guynemer. D. E. Helmuth. This article calls attention to the fact that the Vichy government in France, obviously under the thumb of Berlin, has issued a fifty franc air mail stamp carrying a picture of Georges Guynemer, Ace of the first World War, who had forty-five victories to his credit. The article makes a brief comparison between modern aerial warfare and the individual sky duelling of the 1914–1918 conflict. *Airpost Journal*, March 1941, page 199.

A Yardstick for Top Speeds. To aid in checking speed claims, a method is described which uses the "Everling high speed figure" as a base but also takes account of the effect of high wing loading and changes in air density at varying altitudes. When the motor power, wing area and general characteristics of an airplane are known, its top speed can be estimated from the chart and tables presented in this article. *The Aeroplane*, February 28, 1941, pages 250–251, 6 illus.

Model Airplanes

Gas Engine Census. Photographs, three-view drawings and specifications of thirty-seven Class A, B, and C model aircraft engines. Design features are also described. *Air Trails*, April 1941, pages 28–33, 40 illus.

Planning an Outdoor Contest Arthur J. Vhay. Instructions for judges and managers of model airplane contests, explaining the function of the various official personnnel required for the success of such an enterprise. The general procedure, prizes, releases and other details are outlined. *Air Youth Horizons*, April 1941, pages 5, 6, 1 illus.

Naval Aviation

The Navy Comes to Texas. Allen V. Davis. Describing the physical layout and the current training program of the new Naval Air Station at Corpus Christi. *Southern Flight*, April 1941, pages 15 and 19, 2 illus.

The Naval Aspect of Aircraft Design. Rear Admiral H. G. Thursfield. The need for long range flying boats in the Coastal Command for the protection of convoys against submarine and bombing attacks is outlined by the writer. Recent intensification of German coordinated attack by long-range aircraft working with numerous short-range submarines has caused a shifting of a considerable portion of patrol bombers under the Coastal Command to convoy duty. *Aeronautics*, March 1941, pages 26–28, 3 illus.

Amphibious Powers. A. B. Wren. A study of sea and air power and its influence on the future developments of the War. The writer believes that the future of the British Commonwealth which was founded on sea power must be reborn around a combination of sea and air power. *Aeronautics*, March 1941, pages 32, 33.

Personalities

When History Was Making. C. G. Grey. Episodes in the life of Glenn L. Martin depicting the background which has carried the name wherever airplanes are used. *The Aeroplane*, February 21, 1941, page 232, 1 illus.

S.B.A.C. A brief biographical sketch of Sir Frank Spencer Spriggs, President of the Society of British Aircraft Constructors. *Aeronautics*, March 1941, page 57, 1 illus.

Photography

Through the Gun Sight. Photographs from camera guns wing-mounted alongside the battery of eight Browning machine guns on Hurricanes and Spitfires. The 16 mm. cine-film used is automatically exposed when the machine guns are fired, providing records of the results of combats and information on identity of types in different engagements. *The Aeroplane*, February 21, 1941, pages 228–229, 12 illus.

Action in the Air. Taken on 16 mm. film by cameras fixed in the wings of British fighters aimed parallel to the machine guns. Pictures include one of a bomber disintegrating under fire, and of several showing streams of tracer bullets directed at German bombers. *Aeronautics*, March 1941, pages 30, 31, 6 illus.

Private Flying

The Cost of Owning and Operating Small Aircraft. Cyrl W. Terry and Paul Kellog. Recent increases in the number of private pilots and airplane owners bring up the pertinent question of how much does it actually cost to operate the average light airplane.

After visiting flying fields, interviewing experts, private pilots, service operators and flying club members, the writers collected some interesting data on non-commercial operation of light aircraft.

They have divided the cost of private flying into three convenient groups: overhead, running expenses and airport costs. Overhead includes the cost of the craft, depreciation, interest or payments, and insurance.

The latter is extremely important in the writers' opinions, so its costs, which usually consume 26.2 cents of the fixed charge dollar, are explained. Some private operators believe that insurance against loss of the airplane by accident is the first consideration, but actual practice has shown that liability and property damage should be an important insurance consideration.

Operating costs, figured on the basis of an average light airplane, are broken down both on the percentage and cash basis, and indicate that in average operations, fuel consumes 58.1 per cent of the allotment, engine maintenance 15.1 per cent, airplane maintenance 11.4 per cent, minor repairs 9.1 and oil 1.1 per cent.

All of the other phases of light aircraft operation are discussed and their expense broken down on a yearly and hourly basis. Hints on reducing operating costs are also given. *Aviation*, April 1941, pages 34, 35, 154, 156, 158, 5 illus.

Propellers

The Junkers V. P. Airscrew. A report, made by the engineering staff of Rotol Airscrews, Limited, on the construction and functioning of a Junkers constant speed propeller. The German unit is motivated by oil pressure, uses compressed wood blades and is provided with a unique hydraulic inter-pitch lock. *Aircraft Engineering*, February 1941, pages 32–34, 37, 2 illus.

Airscrew Assembly. Rotol Airscrews, Ltd., in the effort to take advantage of the considerably increased efficiency in mass production through the use of conveyor and rail track systems, have met with much success in a combined track and overhead conveyor system for assembling and finishing their variable-pitch propellers, both wooden and metal-bladed types. The blades pass on an overhead track system through the blade assembly and airscrew departments. The complete range of blade assembly operations has been reduced to a series of planned and timed sequences which may be carried out by semi-skilled labor trained by the firm. The complete operation of this system is discussed with full details on the assembly track, fixtures and handling. *Aircraft Production*, March, 1941, pages 90–95, 14 illus.

Airscrew Development for Maximum Speeds. The increase in aircraft power plant output during the last ten years has made the design of higher speed aircraft possible. This increase of speed and power plant progress has made the "aerodynamic wall," or point at which the compressibility of air becomes a prime factor, an immediate problem. The various approaches to the problems of increased propeller efficiency such as increasing the number of blades, tandem dual rotating propellors, radical blade design and decreased rotational speed as well as the possibilities of jet propulsion are probed in this report. *Interavia*, February 13, 1941, pages 1–3.

Balancing of Aircraft Propellers (Part 3). Murray C. Beebe, Jr. Describing several methods for measuring aerodynamic unbalance and explaining the theory and operation of the apparatus selected as most suitable for measuring experimentally the unbalance of production type propellers. Tests with this equipment are expected to establish the relative importance of aerodynamic and mass unbalance and to determine the degree of refinement with which both types of unbalance must be corrected in order to eliminate objectionable vibration of the aircraft structure. *Aero Digest*, April 1941, pages 102, 105–106, 109, 193–194, 11 illus.

Nagra Aktuella Propeller-Problem; Okade motoreffekter och flyghastigheter staller nya krav pa propellern (Some Actual Propeller Problems; Increased Engine Effects and Flying Speeds Put New Demands on Propellers). Tore Edlen. A mathematical study on propellers which goes into details of propeller speed and its effect on propeller efficiency, propeller torque and its effect on the maneuverability of the airplane and gyrostatic effect of the propeller and its influence on the maneuverability of the airplane. *Flying*, January 1941, 5 pages.

Engine nacelles receive finishing touches before installation at the Douglas Aircraft Company's Santa Monica factory.

Radio

Harvey Directional Automatic Radio Control. A description of the widely discussed radio "homing pigeon" which has repeatedly shown its ability to guide an airplane automatically along a straight-line course joining two radio stations despite cross-wind conditions. The device operates on the principle that opposite angles of intersecting lines are always equal. By activating the rudder with a servo unit, if the craft is ten degrees off course it gets twice the rudder compensation which it would if the deviation were only five degrees. The working, construction and application of the device are explained. *Aviation*, April 1941, pages 53, 152, 2 illus.

Ground Station Direction Finder. Peter C. Sandretto. Although aircraft direction finders utilizing a directional loop antenna and long-wave stations for bearings are firmly

established and in common use, the reverse of this process, locating the airplane from the ground station, presents a more difficult problem. This is due to the irregular characteristics of the medium-high-Ionosphere propagated frequencies used for telephonic radio transmission. This article explains the causes of this difficulty in terms of a simple demonstration with a desk lamp in a room, with an obstruction in front of the lamp.

The method by which United Air Lines Communication Laboratory approached the solution of this question, and the use to which their developments may be put in the future, is described. *Aviation*, April 1941, pages 42, 43, 150, 3 illus.

Stress Analysis

Stresses in Single-Spar Wing Constructions with Incompletely Built-up Ribs. F. Reinitzhuber. Wherever large forces due to engine or landing gear are to be applied to incompletely built-up ribs in single-spar wing constructions, the force distribution requires detailed investigation, which in this study is restricted to the torsion moments for the shear in the wing covering.

It is concluded that the force distribution resulting from the incomplete ribs may be determined with the aid of shear field method by a statically indeterminate computation. A numerical computation is given of the force distribution of a wing structure whose two adjacent incomplete ribs with web missing in half the section are torsionally loaded. In spite of the incomplete ribs, a distribution of the applied forces is obtained over the entire wing cross section and depends considerably on the stiffness of the ribs, particularly of the flanges in the rear part of the tubes and of the manner of application of the forces on the rib. The use of simplifying assumptions permits reduction in the number of static redundancies and thus in the computation work without introducing much error in the results. If two equal and opposite moments are applied at the incomplete ribs, a onefold statically indeterminate computation is already sufficient for obtaining a useful approximate value of the moment contribution of the rear tubes. *Journal of the Royal Aeronautical Society*, March 1941, pages 104–116, 7 illus.

Zum Dreidimensionalen Spannungszustand der Kreisrunden Platte (On the Three-Dimensional Stress Condition of a Circular Plate). H. Swoboda. The thick circular plate in which the load is symmetrically distributed along a circle is generally treated according to the Kirchhoff plate theory, *i.e.*, as a two-dimensional problem. The results are adequate as long as the loads are sufficiently widely distributed. However, they deviate considerably from the actual values if the loads act on narrow areas. Under the effect of a point load, the stresses on the upper and lower rims of the plate grow infinitely large. As it is assumed that the plate is loaded on its upper rim only, there never will be any infinite stresses on the lower rim. The stress conditions may only be determined by means of three-dimensional formulas. *Z.A.M.M.*, December 1940, pages 336–350, 16 illus.

The Torsion of Box Beams with One Side Lacking. The torsion of box beams of rectangular section, the edges of which are strengthened by flanges, and of which one side is lacking, is analyzed by the energy method. The torsional stresses are generally taken up by the bending of the two parallel walls, the rigidity of which is augmented by the third wall. The result was checked experimentally on duralumin and plywood boxes. The torsion recorded was 10 to 30 per cent less than that given by the calculation, owing to self-stiffening. *Journal of the Royal Aeronautical Society*, March 1941, pages 89–103, 9 illus.

Unit Method of Beam Analysis. F. R. Shanley and F. P. Cozzone. Various improvements in the methods of analysis for determining axial and shear stresses in box beams have been combined into a practical tabular method which permits a considerable saving of time. The method also eliminates some of the errors often made through injudicious use of the classical methods of analysis and offers a means of extending the process to include secondary effects, such as caused by "shear lag" and cutouts. *Journal of the Aeronautical Sciences*, April 1941, pages 246–255, 15 illus.

Torsion in Rectangular Channels. H. J. M. Kittlesen. A means of quickly determining the maximum stresses in open sections of rectangular channel subjected to end restraint. *Aircraft Engineering*, February 1941, pages 40, 41, 7 illus.

Warfare

A Letter from England. From John W. Morrison to Cy Caldwell. Lengthy personal observations regarding England's reaction to the war, with notes on American aircraft now in R.A.F. service. *Aero Digest*, April 1941, pages 56, 58, 61–62, 190 and 193, 6 illus.

Fighter Command. A picture survey of life at a fighter command station in England, showing how the pilots fight and live between battles. A comprehensive list of slang which has developed among the R.A.F. personnel is given. The servicing of a Hurricane at one of England's small secret airfields as well as pictures and personal data of some of the leading fighter pilots is also included. *Life*, March 24, 1941, pages 82–89, 28 illus.

The War in the Air. Notes on the increasing significance of parachute-troop strategy and the development of the parachute arm of future armies. Great Britain is warned to keep pace with these developments. *The Aeroplane*, February 21, 1941, page 217, 1 illus.

Middle East Defensive. Captain Norman Macmillan. The usefulness of the modern airplane as a defensive weapon will be best shown, according to this writer, by its effect in the defense of the Middle East. Great distances with lack of railroads, water or other ground communications permits the airplane's good qualities to be exploited to the utmost. In open spaces where the moves of the enemy are easily detected, the strategy of both attacker and defender must conform to the conditions of terrain and climate. Tactical use of aircraft, according to this writer, has not changed in this area since the time of Allenby. Straight observation, bombardment and attack in open country show the airplane at its best as a military weapon. The defeat of the Italian army in Africa is given as proof of this contention. *Flight*, March 6, 1941, pages 191, 192.

Waiting for the Blitzkrieg. C. G. Grey. In a letter from London, the writer gives the British view of the long-awaited German attempt to invade England. The latest missile which has been rumored to be ready for use by the Luftwaffe against objectives in England is a giant four-ton bomb. With this projectile, the effect is either a terrifying hit or a frightful waste of material and carriage if it misses. Its effect cannot be spread lengthwise or crosswise over

a target area as one could with a stick of bombs.

It is said that a gas attack against England would not be completely effective, as England is usually windy almost all year 'round. This differs from Central Europe which frequently has flat calm periods.

The much heralded glider trains, troop carriers or parachute infantry would, according to this writer, also be ineffective as invasion units. *Aviation*, April 1941, page 30, 31, 3 illus.

The War in the Air. A review of the changes in air warfare tactics since the beginning of the present war. Emphasis is placed upon the necessity for versatility in aircraft as evidenced by the trend toward heavier, higher-powered fighters and lighter, faster day bombers. The development of engines rated for greater heights is said to be the most wanted improvement of the moment. *The Aeroplane*, February 28, 1941, page 245, 1 illus.

War in the Air. Summary of recent British air operations in the eastern Mediterranean and Africa. Air reinforcements at Singapore are described and civilian bombing casualties for January are compared to those suffered during the autumn months. *Flight*, February 27, 1941, pages 169–171, 2 illus.

Air Strategy—XLI. Attack against Britain—II. Lessons of the Tactical Employment of Fighters and Bombers in the Present War—IV. Captain Norman Macmillan. Comparing the tactical position of the maritime *vs.* the land power, the extended use of fighters for new operations, such as mining of inland waterways, is urged as an effective complement to the application of external blockade by the naval power. To permit full value to such uses of the fighter, it is suggested that its range can best be widened by adding tankage without adding too much resistance.

Germany's use of bombers in mass concentration is said to have resulted in the bombing of whole areas in England without causing a considerable amount of damage bearing directly on Britain's war effort. It is taken to mean that Germany has adopted this policy in the absence of effective intelligence service in England for measuring results of air blockade, being forced to seek by weight of attack what could not be achieved or confirmed by other tactics. It is concluded that the flyweight has shown "clever sparring," while the bomber has "failed to land a knock-out." *Flight*, February 20, 1941, pages 155–157.

Arena for Fighters. A report on recent aerial warfare over Northern France, the Mediterranean and Balkan fronts. Mention is made of new German bombing tactics—the dropping of high explosive and incendiary bombs together. *The Aeroplane*, February 28, 1941, pages 246 and 247, 3 illus.

The Growing Night Offensive. A report of night bombing activity by the R.A.F. Bomber Command on objectives over the French coast, which states that little or no opposition from intercepter aircraft was encountered during the raids, but that anti-aircraft fire was accurate and vigorous. An account of the R.A.F.'s Hurricanes operating against the Regia Aeronautica in Africa shows numerous victories in East Africa, Abyssinia and the Greek front. *The Aeroplane*. March 7, 1941, pages 72, 73, 3 illus.

Germany's Secret Plans for Invading England. Wythe Williams. Excerpts from one of a series of the reports to Hitler prepared by the German General Staff for use in planning the assault on England and for use in persuading his Axis partners to proceed according to the German plan. The writer states that the excerpts are verbatim copies, and this article is based upon reports dealing with plans for the air attack. It is said that the German High Command estimates that a ten-to-one superiority in equipment and personnel is needed to gain necessary control of the air as well as carry on the preliminary bombardment of industrial areas designed to "soften up" England for the invasion attempt. The report voices the belief that such superiority has been achieved. It is stated that 82,000 combat aircraft will be ready by April 1 to deal with an estimated 5,000 defending the British Isles. American aircraft are dismissed as not to be considered a military factor. In an editorial note Mr. Williams states his belief that the Germans have underestimated English air strength and aircraft production. He also points out that at the time the report was written, contemptuous dismissal of American airplanes may have been justified, but no allowance has been made for the American capacity to increase production under stress. Other interesting information contained in the reports include mention of a Junkers bomber designed to operate at 40,000 foot altitude, and a transparent plastic Heinkel bomber which is believed capable of speeds up to 400 m.p.h. with full load, both to be in production by spring. Other details on aircraft factories, equipment and flying personnel are also given. *Liberty*, April 5, 1941, pages 32–36, 2 illus.

Welding

Spot Welding Development at the Arado Works. E. Reichel. An account of four years of experimental work done at the Arado plant in Germany, during which several types of electric spot welding machines were tested on many light alloys. The tests determined that with the correct type of spot welding device, applied to adaptable alloys, welding can be successfully substituted for riveting. It was also determined that there was a definite increase in fatigue strength over a similar part assembled by conventional riveting. *Aircraft Engineering*, February 1941, pages 49–54, 26 illus.

High Speed Production Spot Welding of Aluminum Alloy. Description of design and operating characteristics of a new spot welder which is said to produce welds in aluminum alloy with a uniformity equal to that possible in production-welding of steel and with a strength beyond that required by government specifications. The equipment operates on a principle using all three phases of 3-phase alternating current, the proper wave form for the weld being developed in such a manner as to permit accuracy of control of welding current. A timer adjustment provides correct welding time for any type of aluminum spot welding job, and automatic repeat timing permits the making of any number of welds in succession without reclosing the pilot device for each weld. *Aero Digest*, April 1941, pages 121–122, 6 illus.

Spot Welding Investigations. Review of the first interim report of the R52 subcommittee of the Research Council of the Institute of Welding (British), dealing with the strength and behavior of spot welds in light alloys. *Aircraft Production*, March 1941, page 101.

Spotwelding "18–8" Stainless. Carl de Ganahl. Elaborating on the properties of "18–8" in relation to spot welding in airplane construction, this article entails methods of application derived from a decade of pioneering effort in the field and defines new uses for this type of construction. *Commercial Aviation*, March 15, 1941, pages 60, 62, 64 and 72, 9 illus.

House Organs and Catalogues

Tappet Design and Operation

Tappet and Cam Contact Stresses. This discussion of tappet design and factors affecting their operation, considers the general types of tappet designs available. Of the various known designs, the flat-faced type is indicated to be the one most commonly used. The common causes of failure, the stresses on tappet faces and common production and design considerations are outlined. Unusual conditions under which failures are known to have occurred are also given. Wilcox-Rich Div. of Eaton Mfg. Co., *Wil-Rich Forum*, March.

Aircraft Finishes

Useful data on finishes for aircraft fabrics and metals is presented in a bulletin by the Monsanto Chemical Company. Included is information on U.S. Army and Navy specification finishes, procedure and schedules for fabric and metal finishing, metal surface cleaning and upkeep of finished surfaces. A glossary of terms applied to aircraft finishes is of interest. Data on Monsanto plastics and on containers used in shipment of finishes complete the 43-page booklet. *Monsanto Aircraft Finishes.*

Casting Inspection

A mechanical method for finding porous castings before they are machined is the subject of a folder issued by Andrews and Perillo, Inc. The instrument used gives a definite numerical value for the porosity of the whole casting and is said to be valid for castings too complicated in shape to X-ray. It will also detect pockets of sand or oxide, although it is much less sensitive to these than to voids. Designs are available for castings weighing from one ounce to half a ton. *Inspection for Porous Castings.*

Doctors with Wings

Australian Flying Doctors. J. Hughes. Before the popular use of aircraft in Australia, if illness or accident occurred in the sparsely inhabited country, the patient had to be rushed over rough country to help, or trips of 250 to 500 miles frequently had to be made to the nearest telephone in order to summon aid. In 1928, the Australian Inland Mission began their experiments with radio communication and aircraft as a method of getting medical aid to those who needed it in outlying places. Since then, a system of radio transceivers has been established in strategic places, and hospital airplanes have been placed in five key locations. The organization, known now as the Australian Aerial Medical Services, is capable of rushing help to any spot on the continent. *The Intava World*, March.

The backlog of Bell P-39 "Airacobra" fuselages stored at the Bell Aircraft Corporation's plant at Buffalo, N. Y.

Linen Substitutes

Development of Substitutes for Strategic Linen. B. A. Holgate, Jr. In view of the potential supply of linen fiber being insufficient to Air Corps needs, alternative non-strategic domestic fibers are being sought. Analysis of the specification requirements for linen are said to show that nine of the ten samples of linen webbing are not designed for full efficiency, using the strength-weight ratios of samples as their construction efficiency.

Investigation of substitutes on the basis of strength-weight ratio shows Nylon to be of high strength, though it is about three times as expensive as cotton. Tests of Pima cotton, a special domestic variety, establish it as being of an average staple length suitable to substitution for linen and less expensive than linen; furthermore the physical and chemical characteristics of cotton have been thoroughly investigated whereas those of Nylon are not fully known. A table is given showing the relative strength-weight ratios of ten corresponding types of linen, cotton and Nylon. *Air Corps Newsletter*, March 15.

Radio for Light Planes

Flyweight Receiver-Transmitter Doubles Your Radio Dollar Value. Air Associates' new radio for light airplanes is a two-way unit with phones and microphone, weighing only $10\frac{1}{2}$ pounds. The radio control panel is built to fit the standard Army-Navy instrument opening. Operation is from small, high-output dry-cell batteries which are available at all radio shops and provide sufficient power for 100 or more hours of receiving and seven to eight hours of transmitting operation. *Air Associates News*, April.

Rating Schools

To Set Mechanic School Standards. Out of the February N.A.T.A. meeting at Kansas City has come a move to organize aviation mechanic or technical schools for the purpose of establishing a code of high standards applicable to all types of training institutions in the ground division. As an initial step toward establishing a system of rating schools, the meeting adopted tentatively an outline of regulations for membership guidance. The outline adopted was directed largely toward regulation of sales, advertising and publicity policy and procedure and of claims and assertions made by schools in soliciting students. *N.A.T.A. Climb*, March.

Before Takeoff

"O.K. for Delivery!" High-lighting the all-important duties of the hangar crew who tune up, "rev up," and fuel Airacobras for their initial takeoff, this article indicates the confidence that pilots must place in these last-minute preparations. Careful and painstaking workmanship is vital. *The Bellringer*, April.

Overshoes for Airplanes

Aircraft Icing and De-Icing. George W. Sawin. A study of the formation of ice on aircraft, indicating the various conditions under which ice is known to accumulate. The Goodrich de-icer, developed under the direction of Dr. W. C. Geer, then vice-president of Goodrich in charge of Research, proved to be a practical method of coping with this condition. The experiments leading up to the almost universal acceptance of rubber de-icers, their functioning, present application and manufacture are outlined. *The Intava World*, March.

Biography of Kelly Field

Uncle Sam's Finishing School. The last stop that the pilots of the Army Air Corps make as cadets is the advanced training base at Kelly Field near San Antonio, Texas. From primary training at the much publicized and glamorized Randolph Field, cadet pilots come here to find the station old fashioned in architecture and rich in tradition. The field was named in honor of Lt. George M. Kelly who lost his life in an airplane accident at Fort Sam Houston in 1911. The history, progress and present functions of this station where pilots enter as cadets and leave as Second Lieutenants is given in detail. *Form One*, March.

Ceramic Insulation

Improved Spark Plug Development. The Materiel Division Correspondent. After a year and a half of intensive experiment with ceramic-insulated spark plugs, the Materiel Division of the U.S. Army Air Corps has approved two new types of plugs with ceramic insulation, which is expected to eliminate the difficulty experienced with mica-insulated plugs in the newer high-output engines. Under excessive loads or with fuel somewhat below specification requirements, the scaly deposit on the mica plugs becomes warm and serves as a conductor rather than an insulator, thus causing the plugs to stop firing. Characteristics and advantages of the new type plug are reported. *Air Corps Newsletter*, March 15.

Engine Thermostats

A 28-page data book published by the Fulton Sylphon Company presents 38 standard types of engine thermostats, said to be representative of many different types and sizes available. Sectional engineering drawings and illustrations show the location and method of installation of each type; those shown include thermostats for aircraft, marine and land engines. *Automatic Thermostats.*

Industrial Felt

Felts for Sealing and Lubricating Bearings. The various properties and applications of felt used in mechanical assemblies are described and illustrated in a pamphlet intended for engineers and designers. The illustrations show different methods of using the felt, some of which are standard practice, while others represent a departure from common usage. *The Felters Company, Incorporated.*

Production for the Layman

Hatching Warbirds. Seeking a better understanding by the public regarding the fundamentals of aircraft production and the problems unique to this industry, the importance of flexibility in aircraft design and application is set forth in a summary of the labyrinthian steps involved in the conception and production of an effective military airplane. The straightforward story told here makes clear the necessity for *time*—for a thoroughly exhaustive, and detailed approach to airplane design and production, despite the critical need for more airplanes in a shorter time. *Northrop Aircraft, Inc.*

Diesel Progress

Diesels for Defense. Joseph Pelkey. Ten years of work and an investment of $1,500,000 by S. A. Guiberson and his son Allen produced a lightweight radial Diesel engine suitable to use in aircraft—so much so that after thorough testing the U.S. Government now has them under production at the rate of ten a day at the Buda Company of Harvey, Ill. Weighing 653 lbs., the nine-cylinder, radial air-cooled engine is rated at 310 hp. at 2,150 r.p.m. Its construction, economies and advantages over gasoline-powered engines are told. *Shell Progress*, April.

Military Contracts

Specification Engineering. Part II. Peter A. Beek. A sequel to an article published in the December issue of the *Aircraftsman*, outlining the procedures carried out in executing the various phases incident to the negotiation and completion of contracts covering military aircraft. A further discussion of the procedures will be published in future issues. *Lockheed Aircraftsman*, March.

Subcontracting for Defense

What General Motors Is Doing for National Defense? In picture and story comes a report on G.M.'s progress in National Defense efforts. Allison Division continues expansion looking to a capacity of 1,000 aircraft engines a month by the end of the year. Buick Motor Division is soon to begin production of Pratt & Whitney radial, air-cooled engines at 500 a month. Fisher Body is about to start its manufacture of parts and sub-assemblies for 100 twin-engine, North American bombers monthly. Rochester Products Division has under way the production of airplane control and instrument items. A good picture of the role of subcontracting in the race against time. *GM Folks*, March.

Mass Engine Assembly

New Engine Assembly Building with Conveyor System Completed by Pratt & Whitney. A description of this new addition to the Pratt & Whitney plant where engine parts manufactured in other buildings converge and are distributed upon a continuous, automatic, overhead conveyor to storerooms or from storerooms to stations on the assembly floor. Conveyors and other features of the building were designed to permit straight-line assembly of engines. The final assembly line is equipped with overhead monorails with chainfalls and a series of switches, allowing for the shifting of heavy parts up, down or out of the line at any time, thus maintaining uninterrupted flow of production. United Aircraft Corp., *The Bee-Hive*, January-February.

Dive Bombing

The Navy Learns Quickly. Douglas service schools are teaching Navy fliers and technicians the operating and maintenance details of SBD dive-bombers, forming an important link between the men who build the airplanes and the men who fly them. Reporting on the method of training and the mutual advantages derived by the Navy and the Douglas organization, an account is given by a Navy flier of his first flight at the controls of the SBD-2 with previous training for it in the ground-school only. *Douglas Airview*, March.

Spotwelding

Spotwelding Is Becoming an Important Factor in Aircraft Production. Spotwelding is assuming a commanding role in Airacobra production as more and more non-structural parts are being fabricated by this type of fusion—cowling, fairing, scoops, ducts, tunnels. Bell's welding research department is working toward the use of this method for the making of many structural parts as well; a great deal of primary structure is already being designed for spotwelding. The characteristics and results of the spotweld process are briefly described. *The Bellringer*, April.

1941 Porterfield Models

Brochure giving details and specifications of the Porterfield 65 Trainer and the Custom 75. The former cruises at 100 m.p.h. with a stalling speed of 36 m.p.n. while the Custom 75 cruises at 108 m.p.h. and lands at 40 m.p.h. The Company claims a safety record of fifteen years without injury to pilot or passenger through structural failure. Other features and performance specifications are given. *Porterfield Aircraft Corp.*

Three-Place Cloudster

Description and performance data on the 1941 Rearwin Cloudster. Powered by a 120-hp. Ken-Royce radial engine, the Cloudster has a top speed of 135 m.p.h. and cruises at 120 m.p.h., with a cruising range of 625 miles. Many features are listed and interior details are shown. *Rearwin Aircraft & Engines, Inc.*

Fairchild Progress

An illustrated, comprehensive report to the stockholders of the Fairchild Engine and Airplane Corporation. In addition to the customary balance sheet on the year's operations, the booklet shows current production models together with pictures of plant expansion and a Duramold process fabricated stabilizer. Research and engineering development are also discussed. *Fairchild Engine and Airplane Corporation, Report for 1940.*

Powerful New Transmitter

United Develops Most Powerful Aeronautical Ground Transmitter. A new 5,000-watt radio transmitter, described as the most powerful aeronautical ground station transmitter in the world, has been developed by United Air Lines' communications laboratory. It is a combination receiver-transmitter with a large directional receiving antenna for ground reception which is said to eliminate static and other interference almost completely. It is expected that use of the new transmitter will enable planes to hear ground stations under virtually all weather conditions. Replacing the 400-watt transmitters used formerly, they will be placed at key points along the United system routes, operating at ten different frequencies. *Boeing School News*, March.

Boeing Defense Training

Training for Defense. Boeing's program of training for defense has three branches, all of which have the cooperation of the Seattle Public School system, the University of Washington and many state and federal educational authorities. Trade extension classes and foremanship seminars are held for present employees to provide opportunities for self-betterment. The trade preparatory program, sponsored by the government enables otherwise inexperienced men to secure some knowledge of aircraft work in anticipation of jobs in various defense plants. The services rendered by these classes are explained. *Boeing News*, March.

Precision Watches

In a folder of photographs, Longines present a number of models of precision instruments, including the center seconds watch and the chronograph, all designed to meet requirements of civil and military technique. *The Longines Wittenauer Watch Company.*

Advanced Training at Barksdale

A report on the progress of cadets from Randolph Field, who are receiving their advanced training at the newly established advanced flying school at Barksdale Field, Shreveport, La. Among the changes in training routine said to be instituted at the new base is the division of cadets into pursuit and bombardment groups and their assignment to this particular type of equipment almost immediately. This procedure is said to accelerate training. *Form One*, March.

Buccaneer Record

National Airlines Cyclone-Powered Lodestar Makes Transcontinental Transport Record. Using a stock Lockheed transport airplane, powered with Wright Cyclone engines, a National Airlines flight recently covered the route from Burbank, Calif. to Jacksonville, Fla., at an average speed of more than 240 m.p.h., clipping an hour and four minutes from Howard Hughes' 1938 mark for the same trip. An explanation of the flight is accompanied by a description of the progress of National Airlines and its services. *Wright Aeronautical Corp. Trade Winds*, March.

Screw Products Data

In a 16-page bulletin issued by Aircraft Screw Products Company, specifications, standards and typical applications of "Aero-Thread" screws, studs, bolts, tapped holes and nuts are described and illustrated. *Engineering Standards and Technical Information.*

Painting *via* Conveyor

Wright Aeronautical's Line Conveyor Technique Speeds Painting of Cyclone and Whirlwind Parts. For the painting of engine parts, the brush and time-consuming handling have been eliminated at Wright Aeronautical Corp. by the introduction of two endless conveyor chains—one for cylinders and the other for crankcase sections. A 100 per cent increase in production has been attained in the painting of large crankcases alone. The operation of the conveyor system and the methods for controlling it for standard results are explained. *Wright Aeronautical Corp. Trade Winds*, March.

Employees Handbook

Wings for Your Work. A handy booklet has been prepared by Transcontinental and Western Air, Inc., to acquaint its employees with the history, aims and ideals of the organization and with the privileges and conveniences at the disposal of employees. A route map, organization chart and index add to the completeness of the pamphlet.

Military Air Training

Résumé of the military training activity at the Spartan School of Aeronautics. During the last twenty months 70,000 hours of instruction have been logged by Flying Cadets of the U.S. Army Air Corps. Flying Instructors have averaged 2,800 hours each and the present fleet of 98 training airplanes requires about 3,000 gallons of gasoline each flying day. *The Spartan News*, March.

Materials Conservation

Douglas Scrap Reduction Shows Big Improvement. How Douglas saved materials during 1940 in sufficient quantities to built 37 attack bombers or 28 military transport airplanes is explained in a report of the company's campaign to reduce waste. Among other materials recovered were 22½ tons of rivets and nuts swept from the floors last year. *Douglas Airview*, March.

News Review

(*Continued from page 7*)

4,500 mile route from Seattle to New York in 27 hours.

April 10. Major General H. H. Arnold left for England for a personal study of defense strategy.

April 10. The Defense Plant Corporation allocated $45,412 for the construction and equipment of a jewel making establishment in Perth Amboy, N. J., to assure an adequate supply of jewel bearings needed for aircraft instruments.

Inspector's Manual

The safety of any airplane depends in no small measure on the skill and honesty of the factory inspectors. To do his job well, an inspector needs broad technical knowledge which will permit him to understand the problems of the engineers whose ideas he must safeguard, as well as those of the craftsmen whose work he must constantly check.

The text deals exclusively with the requirements of an airworthy airplane and the method of determining when such conditions are met. The material of which an airplane is built must be up to the specifications called for by the designer. The standards for determining the fitness of steel, both sheet and tube, drop forgings, light alloys, and wood and fabric to be used in airplane building are explained. Corrosion control, particularly in marine aircraft, requires particular care. Procedure for inspection of painting, plating, anodizing and other methods of protecting surfaces is outlined.

Inspection of machined parts requires more complicated tools and detailed observation. How tools are used to judge the standards for acceptance is also treated.

The modern airframe itself consists of plates and extrusions of light alloy, steel tubing, or wood, joined together by various methods. Inspecting these joints is almost an art in itself. The method of detecting inferior riveting, welding and joining, by visual or magnaflux inspection, is described. Some of the new high speed riveting methods now used to accelerate production and the method for determining their fitness is outlined.

A similar approach is made to the inspection of wooden and metal wings, tail surfaces, fuselages and covering, indicating places where weaknesses might occur, where mistakes might be made, or where inferior workmanship might be overlooked. From here, the inspected components go to final assembly. Sample inspection charts are provided, indicating the points at which the airplane, now nearing the flight stage, must be checked for material defects, errors in assembly or inferior finishing.

Power plant inspection occupies an important portion of the book. The inspector's job begins when the engine is uncrated; his responsibility from the time the protective grease is removed. Mount inspection, which rechecks the power plant for inferior workmanship on the part of the manufacturer or damage in transit is treated in great detail. From this point, the volume covers the task of inspection through checking the power unit in the fuselage, its fuel, cooling, lubricating and electrical system.

Finally detail inspection of landing gear, empennage and wing erection, cowling, installation details and armament are given. The text closes with a chapter on the organization and control of inspection systems.

The book is simply written for the purpose of helping mechanics and technicians to rise to inspector's posts. It is free from complicated terminology or involved formulas, and all of its pages discuss practical problems as they exist in factories today.

Aircraft Inspection Methods, by N. C. Bartholomew; Pitman Publishing Corporation, New York, 1940; 131 pages, $1.25.

Books reviewed in this section may be purchased, or borrowed without charge, from The Paul Kollsman Library, Institute of the Aeronautical Sciences, 1505 RCA Building West, Rockefeller Center, New York, N. Y.

Presenting—Flight

The growing profusion of primers on aircraft building and repair makes it comparatively easy for the general reader or student to select introductory material to meet his specific purpose. But with the rapid stream of changes in design and construction, new manuals are as necessary as they are welcome. An interesting survey of the fundamentals of construction and maintenance in simple language, well clarified by a quantity of drawings and illustrations, is presented in *Flight—Construction and Maintenance.*

A thorough study of the subject is given, from the making and reading of blueprints to the rigging of an airplane and the design of its propeller. Sections on woods used in airplane construction, metallurgy, and oxyacetylene welding, round out a complete picture of construction problems and operations. For so vast a subject, the chapter on maintenance is well-ordered, if meager. The compactness of the material makes for easy assimilation by any beginner. For the student, the quiz questions and answers at the end of the book serve to point up the text.

The companion volume (*Flight—First Principles*) is correspondingly simple in its approach to the study of elementary flying principles, and is handled in the same style. A large introductory space is given to an interesting account of transportation as a business, outlining its evolution and the role of Aviation as the newest form of transportation.

The theory of flight and aerodynamics comprise roughly a third of the book and are presented intelligibly. A chapter on soaring illuminates this fascinating field of aeronautics for the beginner, and a closing section on parachutes is interesting, but fails to provide a needed summary of the book as a whole.

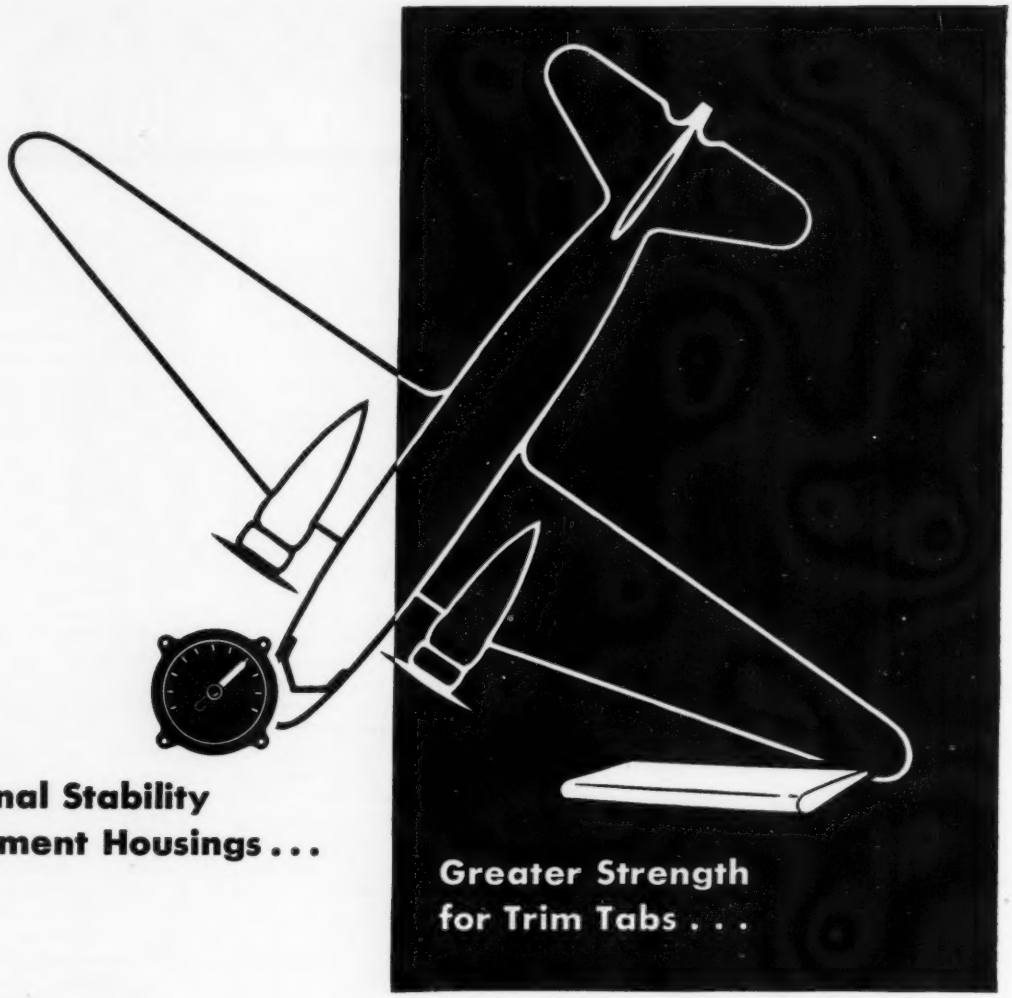
Flight—Construction and Maintenance, by Capt. Bailey Wright, W. E. Dyer and Rex Martin; The American Technical Society, Chicago, 1941; 259 pages, $2.50.

Flight—First Principles, by Capt. Bailey Wright, James J. Smiley, Jr., and Rex Martin; The American Technical Society, Chicago, 1941; 283 pages, $2.50.

Practical Flying

A reprint of the 1937 revised edition, this work provides an instructive summary of the essentials of air navigation in cross-country flying. The foundation of the study is the ground work which the author deems a necessary preliminary to air work. This consists of an examination of the instruments, calculations and influential factors incident to the planning and execution of a practical flight.

How to Find Your Way in the Air, by G. W. Ferguson; Pitman Publishing Corporation, New York, 1940; 85 pages, $1.40.



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The Engineer's Sketch Book, by Thomas Walter Barber; Chemical Publishing Co., New York; 1940, 355 pages, $4.25.

Power Plant Theory Text

In a single volume, much of the scattered primary theory on the building of internal combustion power plants, accumulated over a period of thirty years, is collected and their conclusions directed toward their particular applications in modern aircraft. The text opens with a thorough study of the thermodynamics affecting the internal combustion engine, beginning with the application of Charles's and Boyle's laws, and explains the various types of expansion, compression-ignition, constant and variable pressure cycles.

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Aircraft Engines, by A. W. Judge; D. Van Nostrand Company, Inc., New York, 1940; 380 pages, $5.50.

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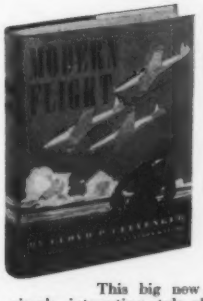

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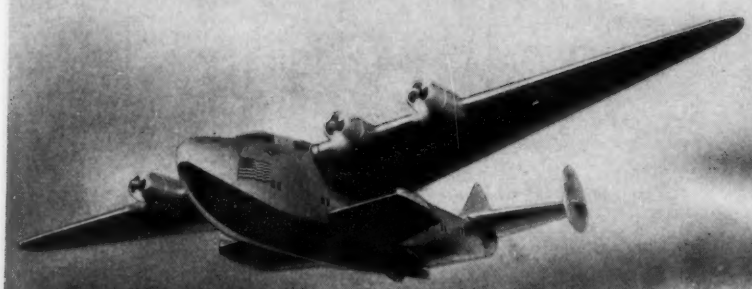

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Aluminum Analysis

The second edition of this standard reference handbook deals with the methods of analyzing aluminum as standardized and developed by the chemists of the Aluminum Company of America. The methods outlined for the precise and accurate qualitative and quantitative analysis comprise the greater part of the material.

The history and background of the various methods of analysis are given, followed by certain necessary basic information on solution and separation of aluminum by various methods.

Actual analytical study starts with an examination of the common impurities found in aluminum and a description of routine analysis. A detailed examination of the elements commonly alloyed with aluminum and of the accepted method for determining the extent of their existence in the sample tested follows.

A chapter is devoted to the study of Albron powder and paste, the powdered metal used in pigments and paints.

Like its forerunner, this text was created to be a handbook for chemists and metallurgists. It is compact, simple and easy to use.

Chemical Analysis of Aluminum, by H. V. Churchill and R. W. Bridges; Aluminum Research Laboratories of the Aluminum Company of America, New Kensington, Pa., 1941; 120 pages, $0.50.

Flight Primer Revised

One of the most popular books on flying instruction, *Your Wings*, in its revised edition is again brought up-to-date.

A practical students' guide, it is profusely illustrated. After the reader has "soloed" the book discusses aerobatics and its importance to the finished flyer. Chapters on avigation, map-making, cross-country flying, meteorology, instruments and military flying follow. In the sections on "Motor Oils and Gasolines," "The Engine and Its Food" and "Radio and Aircraft" technical information is imparted in a simplified manner.

The final chapter contains interesting data on air transportation as well as an account of the author's first flight as a passenger on an airliner.

Your Wings, by Assen Jordanoff; Seventh Edition, Funk & Wagnalls Company, New York, 1940; 282 pages, $2.50.

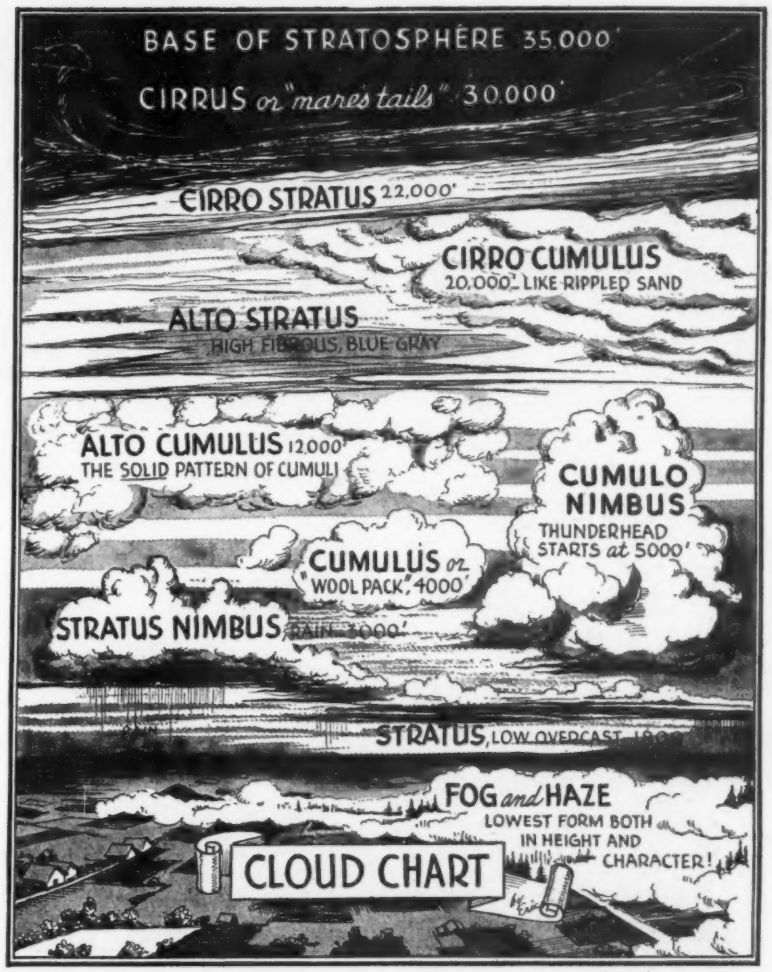
Home Study Course in Blueprint Reading

This series handles most of the common phases of blueprint reading, devoting part of this series of 24 booklets to aviation and related subjects. The approach is unusual, due to the application of the *Shadow-graph* method, which requires the student to visualize blueprints as the patterns cast by objects at particular angles. Much of the early portion is devoted to basic study of what blueprints are, how they are interpreted and how their interpretations are applied.

From this point on, the information is applied to various industries and trades. Some of these studies, such as print reading for threads and gears, precision instruments and patent drawings, machine shop drawings, maps and surveys and welding are indirectly useful to embryo aviation technicians.

The sections on internal combustion engines contain some direct aviation information. Two sections are devoted to print reading of aircraft and aircraft equipment. Although these sections are not as thorough and accurate as they might be and lack sufficient information on modern sheet metal handling, much basic knowledge is pretty clearly offered.

A.T.I. Home Study Course in Blueprint Reading; Austin Technical Institute, Newark, 1941; 24 sections, 576 pages, $8.95.

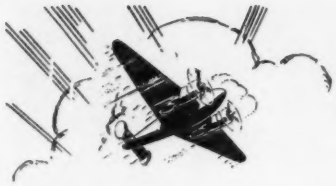


An illustration from Assen Jordanoff's book, *Your Wings*.

Guide to Ground Training

Especially written for applicants for "Ground Instructor Ratings," this text is intended to provide a coverage of examination material on the history of aviation, aircraft and the theory of flight, aircraft power plants, instruments, aerial navigation, aeronautical meteorology, civil air regulations and airtraffic rules. Questions and answers on each subject, and on private, commercial and C.A.A. ground instruction rating examinations, facilitate a summing-up of the field covered.

Ground Instructor, by Charles A. Zweng; Quiz System Publications, Glendale, Calif., 1941; 220 pages, $3.00.



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MONEL								
Annealed	26	65– 85	25– 45	37	50–35	80–105	120–160	120–90
Hot Worked	26	80–110	40– 90	35–52	45–20	125–150	130–220	120–75
Cold Worked	26	85–130	60–115	35–50	35– 2	110–240	160–220	115–75
"K" MONEL								
Not Heat Treated	26	90–165	50–120	38	45– 3		140–250	120–75
Heat Treated	26	130–200	90–145	52	30– 2		260–370	80–40
INCONEL								
Annealed	31	80– 95	25– 40	36	55–35		110–170	over 120
Cold Worked	31	95–170	70–140	44	30– 2		150–250	100–70

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Monel	0.319	2370-2460	.127	.0000078	7.	4.
"K" Monel	0.306	2400-2460	.127	.0000078	5.	3.
Inconel	0.307	2540	.109*	.0000064**	4.	2.

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From the evolution of industry, and of management as its counterpart, the study proceeds to the theory of organization for control and operation. Practical applications and standards are discussed as they pertain to the control of materials in manufacturing, time standards as determined by time and motion study, cost accounting, plant maintenance (and depreciation as an element of cost), labor management and employer-employee relations. The two final chapters are given to summaries on the measurement of performance and research in industrial administration and management.

Principles of Industrial Management, by L. P. Alford; The Ronald Press Company, New York, 1940; 531 pages, $4.50.

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Byrd Meteorological Data

Meteorological data obtained by the two Byrd Antarctic Expeditions, 1928–30 and 1933–35, were previously published in Supplement 41 (1) of the *Monthly Weather Review.* The present supplement contains tabular and graphical summaries of these data.

Monthly Weather Review, Supplement No. 42, by G. Grimminger; U.S. Department of Agriculture, Weather Bureau, Washington, D. C., February 1941; 106 pages, $0.35.

Directions for handling a seaplane in water from the book *Your Wings.*

Second Edition of Drafting Text

While this textbook, like its predecessor, has no direct bearing on aviation, its place as a standard drawing text makes it indirectly important to the industry. Starting from the genesis of technical drawing, the explanation of instruments and materials, it simplifies the drafting mathematics and geometry, explains lettering, various types of projections and views, perspective, intersections and development and presents a complete study of dimensioning.

The chapter on welding, newly added to the text, comes the closest to being direct aviation material. The directions for the execution of topographic drawings and contour maps are also directly applicable to specialized aviation use.

Technical Drawing, by Frederick E. Giesecke, Alva Mitchell and Henry C. Spencer; The Macmillan Company, New York, 1940; 676 pages, $3.00.

Answers on Welding

This volume employs a question and answer method for treating the welding problem. It was evidently written as a handbook for practical welders and welding students, and transmits information through the medium of questions typical of those which a student might ask his instructor.

Various methods of welding—fire, resistance, arc, gas, thermit and fusion—are explained briefly. The book, then takes up such practical subjects as the working of electric welding equipment, the basic theory of electrical welding, the setting up of a job, electrodes, types of joints and their handling, etc. Practice jobs are laid out. Common mistakes are indicated. All common phases of this work are covered, including carbon arc welding and cutting.

Other welding processes are handled in a like manner. After they are explained, the remainder of the book concerns itself with particular problems in welding and the selection of the best methods for accomplishing a particular union for various projects. An entire chapter is devoted to the use of welding in aircraft. The book closes with chapters on heat treating, face hardening and cutting. A glossary of terms and symbols is included. The volume has a plain, straightforward air which should make it useful as a production reference book.

Audels Welders Guide, by Frank D. Graham; Theo. Audel and Co., New York, 1940; 422 pages, $1.00.

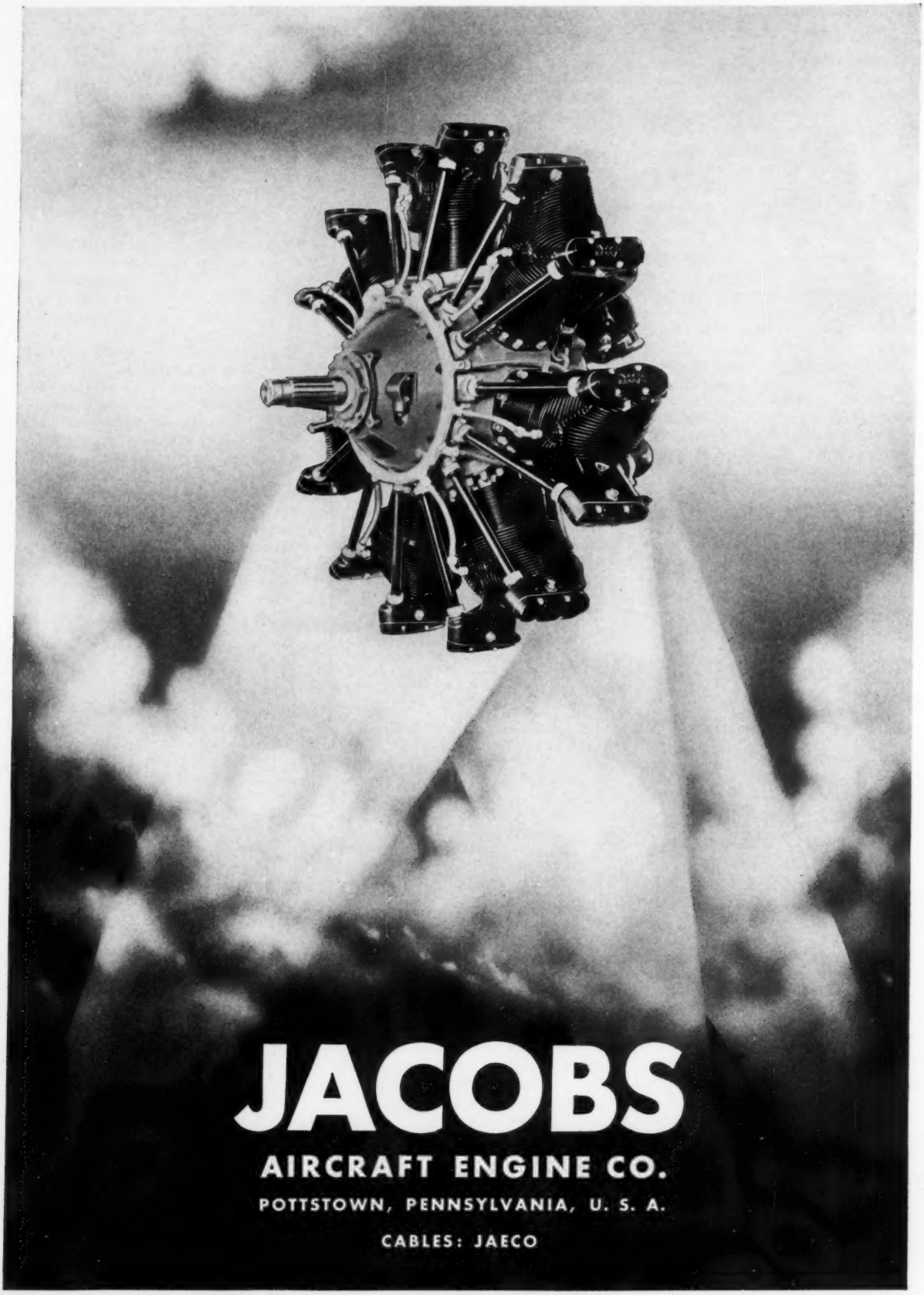
Aviation Careers

The story of two young men who wanted to "get into aviation." Both attended the Boeing School of Aeronautics. One studied to become a mechanic, the other a pilot.

Written in the form of a novel, it traces their progress through school and into jobs with a transcontinental air line.

A "Table of Aeronautical Occupations" is included which lists the various jobs in the field of air transportation.

Flight 7, by Robert E. Johnson; Dodd, Mead & Company, New York, 1941; 242 pages, $2.00.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Light Metals and Alloys

A bibliography giving references for research in this specialized field. Revised and brought up-to-date from the fifty volume Bibliography of Aeronautics compiled and published with the cooperation of the Work Projects Administration from the Aeronautical Index of the I.Ae.S. References have been classified and cross-indexed.

In order to make bibliographies of greater assistance to readers, the editors, with the cooperation of The Paul Kollsman Library, will in this and future issues give a brief résumé of the subject under discussion. The present bibliography on Light Metals and Alloys proved to be of such length as to make its publication in one issue impracticable. The bibliography in this issue therefore concerns itself only with Aluminum. Section 2, which will appear in the June issue of the Review, will give references to Beryllium, Magnesium, Alclad and Duralumin.

Light Alloys

THERE ARE many structural materials available for the manufacture of aircraft and the selection of the materials to be used has always been one of the most important problems with which the designer has been confronted. Any structural material which has the following properties is of importance in modern airplane and engine production: high ratio of strength to weight; low initial cost; ease of fabrication; suitability for close designing; ability to be formed into convenient shapes.

The engineers and metallurgists realize that every pound of weight saved in construction means an additional pound of payload gained, and are therefore continually searching for stronger and lighter materials. The aviation industry has always been willing to pay a higher price for low specific gravity. At the present time the industry is expanding very rapidly and the development, properties, fabrication, and present and future applications of light alloys in the construction of the airplane and its engine offers a timely subject for discussion.

Aluminum Alloys

A survey of the aircraft materials available shows that aluminum alloys are used more than any other material in the construction of the airplane, both in the structure and covering. Practically all airplane fuselages are made of either riveted aluminum alloy or welded chrome-molybdenum steel tubing. The extensive use of aluminum alloys in aircraft construction is due to their high strength, low weight, and ability to be easily formed, machined, welded, riveted and forged with standard equipment.

Aluminum is found in most clays, however, the bauxite ore is the principal commercial source. Pure aluminum is soft and ductile and is used mostly in the form of sheets for the manufacture of parts which are not required to carry a load. It is about $^1/_3$ as heavy as steel and by heat treatment and addition of other elements its strength can be made equal to that of structural steels. Aluminum sheet can be easily shaped into cowlings, panels, etc., but parts manufactured from pure aluminum may buckle or fail at bolt or rivet holes.

The aluminum used in the modern airplane contains from 2 to 10 per cent of some hardening material such as zinc or copper. Some aluminum alloys also contain small amounts of tin, manganese, nickel, silicon and other elements. The properties of the alloy produced can be varied by adding these materials singly or in various combinations to pure aluminum. The copper alloys are more ductile and less porous than the zinc or copper-zinc series. Copper has the same effect on aluminum as carbon has on steel, *i.e.*, after heat treatment it greatly increases the strength and toughness of the material.

Aluminum silicon alloys are ductile and have excellent thermal conductivity and strength characteristics and are now being used for many engine parts. Aluminum silicon alloys also make good castings as they solidify quickly and therefore reduce the effects of strain caused by changes of cross section. Aluminum nickel alloys are highly resistant to corrosion and have the same physical properties as the copper alloys, however, they are expensive and difficult to mix and cast. The addition of tin makes the metal easier to cast, while the addition of manganese increases the tensile strength and hardness of the casting. The strength and hardness of aluminum alloys are increased by heat treatment.

There are two types of aluminum alloys: wrought alloys used principally for aircraft structures and cast alloys used in aircraft engines. There are three methods of making castings: sand casting, permanent mold casting and die casting. Sand casting is the most common and is used in the manufacture of complicated shapes requiring many cores, or when only a few parts are required. Permanent mold casting is similar to sand casting but a metal mold is used which permits the manufacture of many pieces of greater accuracy and smoothness. Die casting is used for producing small parts which must be accurate. The metal is forced into molds and the castings made by this method are superior in finish and accuracy and require less machining than other forms of castings.

Aluminum alloy castings are gradually being used in the manufacture of parts subjected to high stress which were formerly made from wrought alloys. By substituting cast alloys for wrought alloys, components of high strength closely approximate to the final form can be obtained at a lower cost. The use of expensive dies is avoided and machining is greatly reduced as attachments can be built into the casting itself. This simplifies the assembly and also reduces the labor and tooling costs.

The use of castings has, however, not been completely successful, and extensive testing is required before any change is made from a forged to a cast part.

Duralumin

Duralumin was the most important of the aluminum alloys in the early days of metal aircraft construction. There were many other aluminum alloys available but little was known about their properties and characteristics. Duralumin is an alloy of aluminum, copper, magnesium, manganese and silicon. It contains about 4 per cent copper and 0.5 per cent of both magnesium and manganese. Its metallurgy and fabrication properties are well known. The ultimate strength of duralumin is increased about 50 per cent by heat treatment and aging. Its strength/weight ratio is approximately the same as the strength/weight ratio of medium alloy steels. Under certain conditions the corrosion characteristics of duralumin are very bad and it is also subject to intercrystalline corrosion if it is not properly heat treated.

The "atmospheric aging" characteristic of duralumin presents many problems to the airplane manufacturer. One of the main problems is the handling and storage of duralumin rivets. If the rivets are not used when made they age and become hard and cannot be used for cold riveting. Age hardening of duralumin rivets can be delayed by storing them in low temperature containers. This practice of cold storage is often used as it is impracticable to use hot riveting methods for joining duralumin. Duralumin rivets which have been stored at low temperatures must be used within a few hours after removal from the containers. Because of these storage difficulties some manufacturers use pure aluminum rivets for the joining of duralumin.

Alclad

Alclad is the trade name of an aluminum alloy which has been coated on both sides with a layer of pure aluminum. Diffusion of the surfaces in contact is obtained by rolling the alloy sheet at a high temperature between two thin sheets of pure aluminum. This surface layer of pure aluminum protects the alloy which it covers. The tensile strength and yield strength of alclad are about 10 per cent lower than the

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strengths of uncoated alloys. Its properties and characteristics are about the same as duralumin and it can be bent, stamped, cut and welded without affecting its corrosive resistance. At the present time alclad is available in the form of sheets, wire, rods, bars and sections. Attempts have been made to make cast alclad by lining the mold with aluminum foil. Alclad sheets are widely used in the aircraft industry, and where it is subject to severe service conditions, such as in the construction of seaplane floats, it is usually further protected by painting or by anodic treatment followed by painting.

Welding Aluminum Alloys

Pure aluminum and all its alloys may be welded. The oxy-acetylene method has been found to be the best, although at the present time electric spot and seam welding is being rapidly developed. The aircraft industry is greatly interested in this method of production as it has been shown that a spot weld costs only .25 cents while the cost of driving an average rivet varies from 1.5 to 3.5 cents. There is also a saving in production time and the parts manufactured are lighter and have a smoother surface. Although spot welding has these advantages, it has not been used to a great extent in this country except for semi-structural parts, as it is not regarded as a safe method of joining light alloys for use in highly stressed parts. However, its use in Europe has become quite general. Recent tests made by Junkers prove that spot welding can be used without difficulty for joining parts of aluminum and hydronalium. These tests also showed that Elektron presents some difficulties but may be welded, and that at the present time, difficulties of welding duralumin sheet have not been overcome. The use of welding to join duralumin increases its liability to corrosion. The strength of spot welds of duralumin and alclad may be increased by heat treatment and aging after welding. Further knowledge regarding the conditions necessary for the production of spot welds of even quality and predictable shear strengths is required before this method of joining materials becomes common practice in aircraft production.

Magnesium Alloys

The use of magnesium alloys in aircraft construction is increasing and its exponents claim that it will eventually replace aluminum alloys. At the present time magnesium cast alloys are being used for engine parts which are not subjected to excessive heat, and for landing and tail wheels, window frames, housings, equipment mounts, air intake scoops, etc. Magnesium sheets and extrusions are used for such non-stressed parts as wheel fairings, partitions, cabin fittings, seat parts, framing, trimming, oil tanks, etc. Magnesium sheet has been more widely used for fuselage covering, cowling and fairing in Europe than in this country as in Europe these parts are formed by hand while in this country the practice is to press form them. While heating of the magnesium sheet presents complications and requires special equipment, this difficulty has been removed as a hot forming press has been recently developed. Forged propeller blades of magnesium alloy have been manufactured and the application of magnesium alloys to the airplane structure is rapidly increasing.

Magnesium is found in large quantities in this country. It is produced commercially by the electrolysis of molten magnesium chloride. The physical properties of pure magnesium, especially its softness and low strength, make it unsuitable for structural use. Magnesium readily alloys with other elements and alloys can be obtained which have satisfactory strength/weight ratios. Dow Metal and AM alloys are the most widely used magnesium alloys in this country while Elektron is the best known alloy in Europe. These magnesium alloys contain from 88 to 98 per cent magnesium with small amounts of aluminum, zinc, copper, tin, iron, manganese, cadmium and silicon. Zinc and aluminum are the principal metals used for alloying. Magnesium alloys are the lightest commercial alloys available and are about $^2/_3$ the weight of duralumin and $^1/_4$ the weight of steel. The castings have physical properties equal to those of the average aluminum alloy and are about 40 per cent lighter. The wrought alloys have properties almost the same as those of duralumin and are also 40 per cent lighter. Magnesium alloys can be sand or die cast, machined, riveted and welded, but can be bent and formed only with difficulty and have low corrosive resistance, especially when in contact with salt water.

Magnesium alloys have excellent machining qualities. When machining these alloys there is a slight fire hazard which must be guarded against, especially when fine cuts are being made. Magnesium alloys weld as easily as aluminum or steel. They may be welded by any of the known commercial methods, but gas and electric welding are the two methods most generally used. When gas welding magnesium alloys the welding rod must be of the same composition as the material being welded and a special flux must be used. Magnesium alloys may be also joined by riveting, but magnesium alloy rivets are not used because of their tendency to harden when cold worked. Bending, spinning and forming are more difficult than with other metals as magnesium work hardens very rapidly when cold. When heated, magnesium alloys can be worked with ease, and sheets can be formed with regular drop hammers now used in the aviation industry.

Recently magnesium alloys have been considered for use as a material of construction for the entire airplane structure. Results to date have been successful and test wing panels are now being built. As is to be expected, some difficulties have been encountered, but results accomplished indicate that magnesium alloys used in the airplane structure will save weight, reduce costs and increase the aerodynamic efficiency of high speed airplanes. It appears from recent investigations that magnesium alloys should be considered for use in monocoque construction. Tests made on a tail fin of this type of construction showed that a considerable saving in weight was gained by the use of magnesium sheet.

Beryllium

Beryllium possesses many excellent properties which make it of great interest to the engineer. It is as light as magnesium and is very hard. This hardness, which is its most outstanding property, is unfortunately accompanied with brittleness and lack of ductility. The strength/weight ratio of beryllium is about 3 times that of the best aluminum alloy and its modulus of elasticity is 30 per cent greater than that of steel. Attempts have been made in this country and in Germany to produce beryllium on a commercial scale as its high price prohibits its use in airplane construction. The cost of pure beryllium is $30 per lb., however, a recently perfected method of extracting it from ores and residues may reduce its cost.

There are many possible applications for this material in the aircraft industry. It should be useful as a hardener and straightener of other materials, but in such small percentages as not to significantly assist the weight factor. Beryllium's lack of ductility prevents its use in the airplane structure but it can be cast and hot rolled, and its toughness should make it a useful material for armour plate for the protection of flight personnel and fuel tanks. Beryllium will not alloy with magnesium but it will alloy with aluminum. It is possible to deposit beryllium on aluminum alloys and other metals. This coating provides a hard surface which is highly resistant to corrosion. Beryllium has been alloyed with copper and nickel. The addition of 1 to 3 per cent beryllium to these materials greatly increases their hardness and the nickel-beryllium alloys recently developed in Germany and in this country are somewhat non-magnetic, highly resistant to corrosion and have high tensile properties. The use of beryllium on a large scale in aircraft construction depends upon the price at which it can be commercially produced, as compared with stainless steel of similar strength.

Corrosion of Light Alloys

The corrosion resistance of light alloys, with and without protective coatings, is an important factor in their selection for use in aircraft construction. Pure aluminum is highly resistant to fresh water corrosion, but the addition of most of the alloying elements reduces this resistance. Therefore, protection must be given to aluminum alloys especially when used in areas where salt water is present.

Aluminum alloy protective coatings are of three types: organic coverings such as paints, lacquers, varnishes, and greases; metallic coverings such as electro deposits; and chemical or electro-chemical treatment. Anodizing is the most successful method. This is a process for oxide-coating

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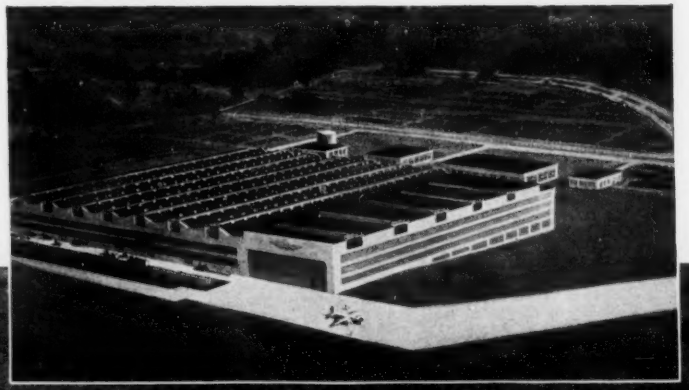
EXPANDING WITH RECORD SHATTERING SPEED, Martin's main plant has been more than doubled in seven months. From 1,263,000 square feet last fall, Martin is increasing to 3,717,163 square feet at Middle River. Other plants operated by the Company will bring the grand total to 5,192,725 square feet—411% plant increase, operating twenty-four hours per day for the National Defense. These additions will make Martin the largest aircraft manufacturer in America. The Glenn L. Martin Company, Baltimore, Md., U. S. A.



NEW ARMY BUILDING at Middle River, 1,181,000 square feet of floor space, in operation by mid-summer. The new, 1,225,326 sq. ft. Omaha Plant, similar to the Army Building, will be completed by November.

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aluminum alloy surfaces, and is specified as a final anti-corrosion finish. Anodizing accentuates any faults present in the metal and although a good sand casting may be anodized, die castings, due to their finer grain and more even structure, give better results. Welded parts can be anodized, but to prevent the weld from showing colors of anodic film, it is necessary to use a welding rod of the same composition as the metal being welded and to avoid spreading the heating effect at the weld.

The main objection to the use of magnesium alloys in aircraft construction is its corrosive characteristics. During recent years manufacturers both here and abroad have devoted considerable attention to the development of methods for protecting magnesium alloys against corrosion. The high chemical activity of magnesium makes the problem of preventing its corrosion a difficult one. Several methods of surface treatment have been developed such as metal coating, chemical treatment, natural weathering, anodic oxidation and mechanical roughing. Tests made in this country, and also in Great Britain, France and Germany, have shown that the best results are obtained from the chemical bath treatment. The object of these treatments is to form a suitable base for the application of paints. In this country, magnesium alloy parts used in aircraft construction are given either a chrome-pickle treatment or an anodic treatment and are then painted. These treatments increase their resistance to salt water corrosion. Magnesium is a highly electropositive metal and its alloys must be insulated from contact with other metals to avoid electrolytic corrosion. Welding corrosion is very easily set up in magnesium alloys and precautions must be taken to avoid it.

Since 1925 the National Bureau of Standards has been investigating the corrosion of metals used in aircraft. The following is a summary of the results they have obtained from tests made on light alloys:

1. The corrosion of alloys of the duralumin type is of two distinct kinds: surface pitting and intercrystalline attack. Surface pitting is similar to the rusting of ferrous metals and can be reduced, at a slight loss of strength, by keeping the iron and copper content low. The intercrystalline type does not appear upon the surface but penetrates into the interior between the grain boundaries. It is largely caused by incorrect heat treatment and causes embrittlement. It can be mitigated by correct heat treatment and control of cooling rates.

2. The best protective coating on aluminum alloys under marine conditions was found to be anodic coatings used in conjunction with a good grade of aluminum pigmented varnish.

3. Intercrystalline corrosion does not occur in magnesium rich alloys. It was found that resistance of binary alloys to corrosion decreases with increase in aluminum content. The addition of zinc to magnesium aluminum alloys improved their corrosion resistance and the addition of 4 to 6 per cent of tin proved very successful. The corrosion resistance of magnesium alloys has greatly improved due to the improvement of purity of the alloying elements used.

4. The surface coatings for magnesium alloys that have been developed are not as efficient as the anodic coatings used on aluminum alloys. However, the coatings used improve the adherence of paints. Tests have shown that good grades of aluminum pigmented paint, used in conjunction with a satisfactory surface treatment, have protected the better corrosion resistant magnesium alloys during five years' exposure to weather at marine localities.

5. Gas welds of both aluminum rich and magnesium rich alloys are very resistant to corrosion. Spot welds were more susceptible to attack, while seam welds were noticeably so.

6. The ratio of the areas of dissimilar metals in contact often proves a determining factor in corrosion. The insertion of insulators between the surfaces appears to give promising results.

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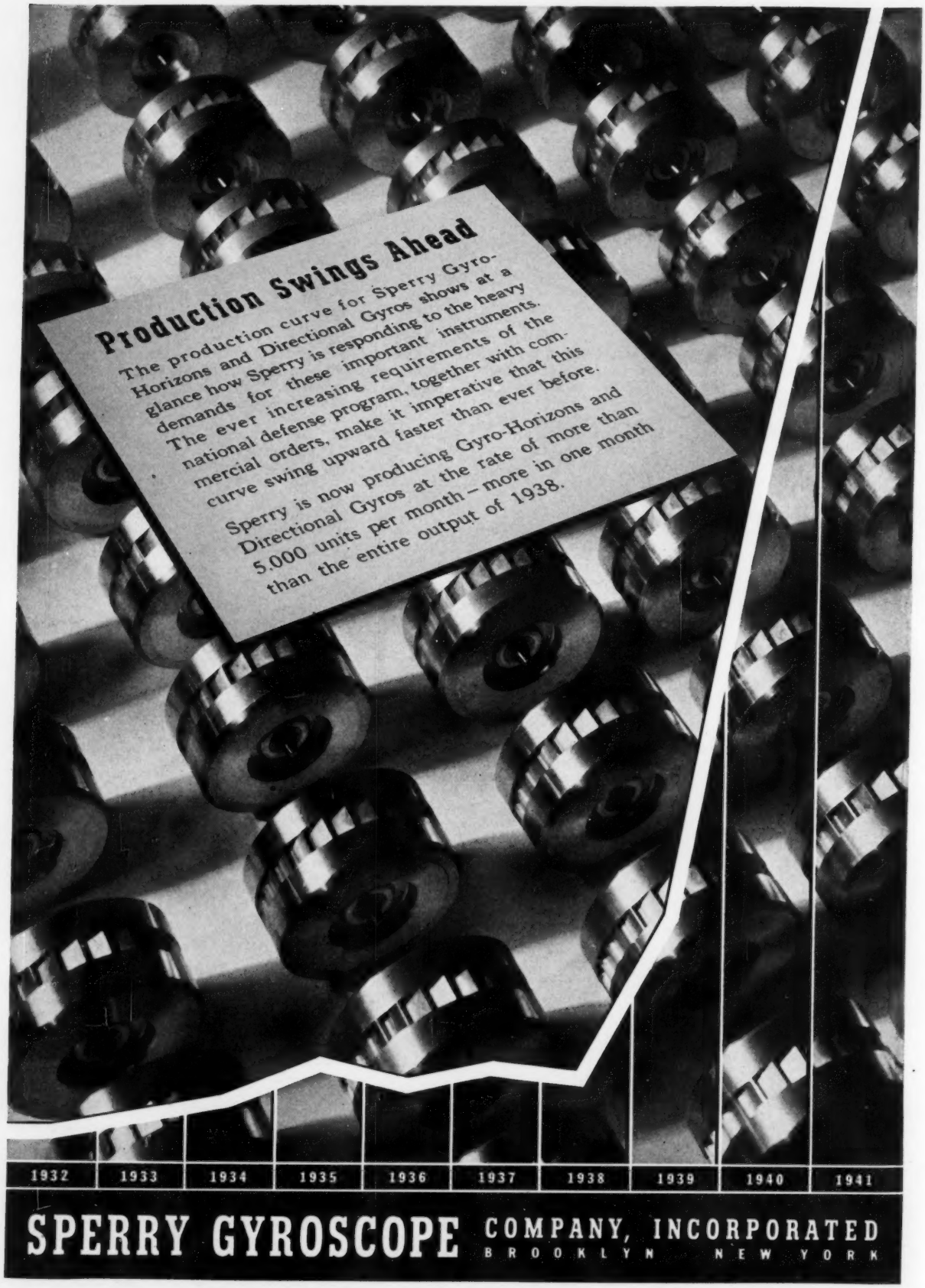
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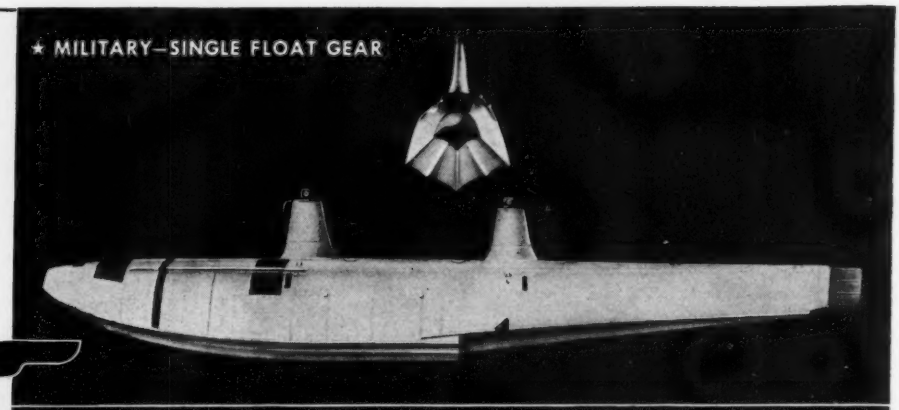

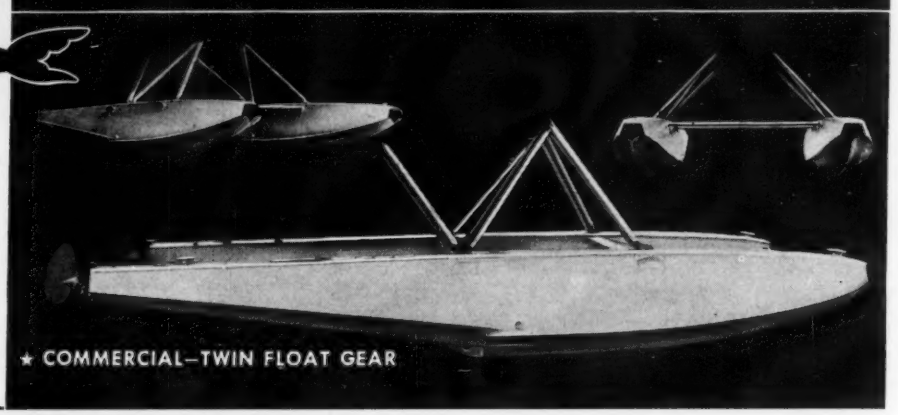

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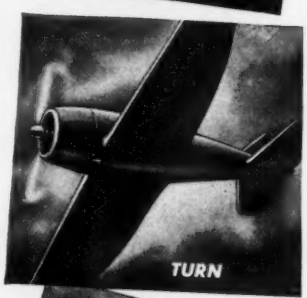

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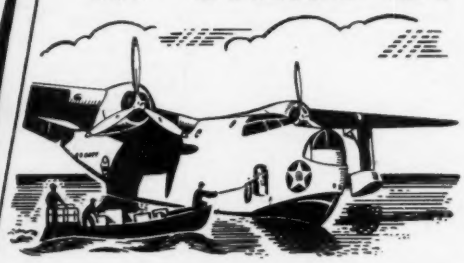

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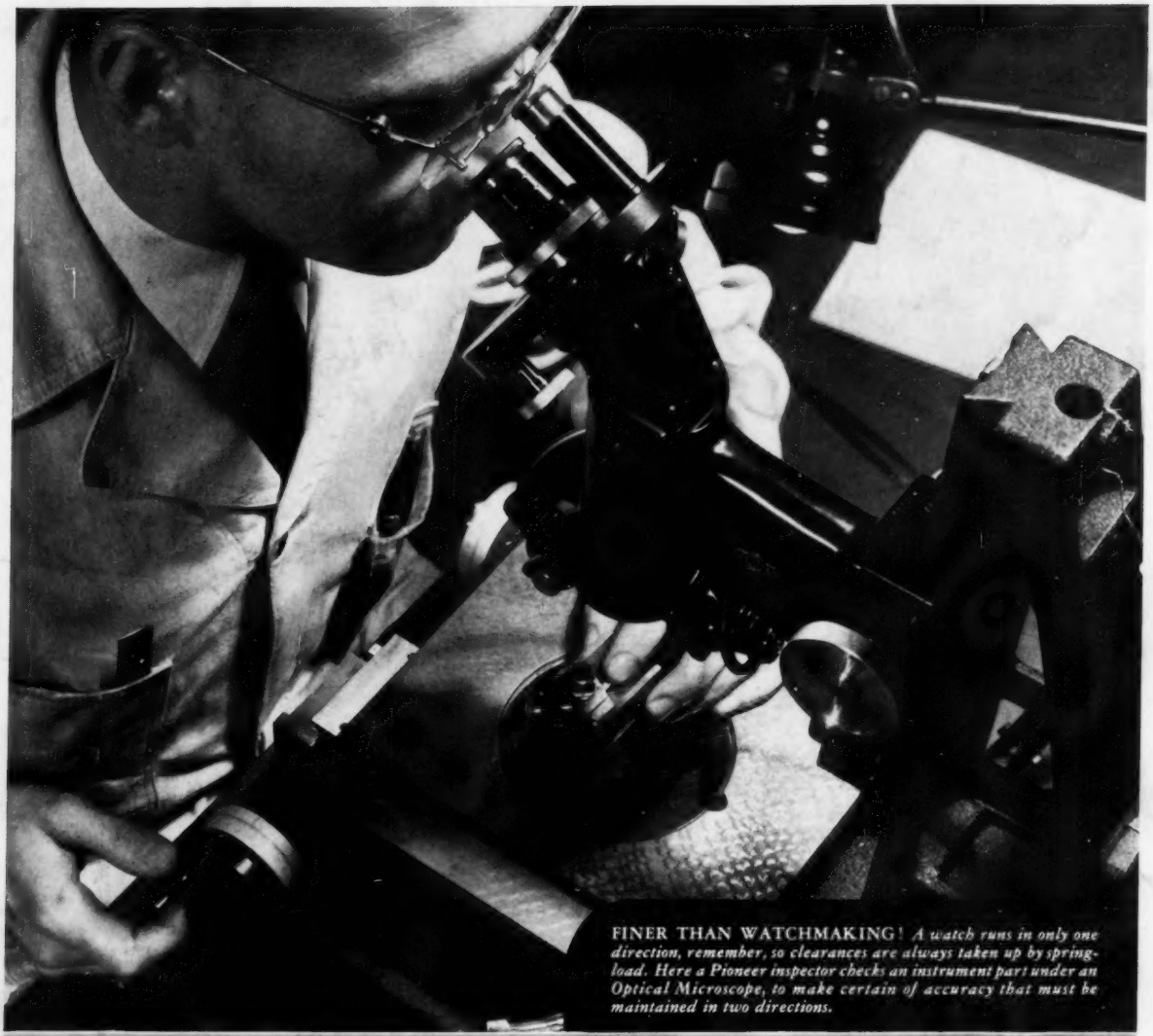

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